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Report No. 4-25

DESCRIPTION OF FACILITIES FOR TESTING  
LARGE-SCALE LIQUID-PROPELLANT ROCKET MOTORS  
AT THE ORDCIT TEST STATION, MUROC

W. B. Powell

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## I. INTRODUCTION AND SUMMARY

The ORDCIT Test Station, Muroc, is a facility for testing liquid-propellant rocket motors delivering up to 20,000 lb thrust. It is located on the grounds of the Muroc Flight Test Base, ATSC, in the desert about 20 miles east of Mojave, California. The test station consists of a test stand and control room with supporting installations such as offices, shops, and propellant storage docks. The operating personnel are quartered at the Base, 2 miles from the test station.

The test station is equipped to test large-scale rocket motors firing vertically downward for periods of time up to  $1\frac{1}{2}$  min. Instrumentation is available to measure all the forces on a 6 component motor support system, as well as chamber pressure, propellant consumption, and time. Auxiliary instrumentation is installed to aid in the control of the motors during tests. All data are recorded photographically by cameras trained on an instrument panel in the control room, which is located 60 ft from the motor being tested.

A feature of the test stand is the 9-ft square vertical duct into which the jet is directed downward. The duct is approximately 20 ft long and at the lower end has a curved deflecting surface which turns the jet into a trench-like excavation at the back end of the test stand. The deflecting surface is lined with carborundum bricks to resist the heat and erosive action of the jet.

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## II. REQUIREMENTS OF THE TEST STATION

The development of liquid-propellant rocket motors of high thrust, of the order of 20,000 lb, made it necessary to provide testing facilities adequate for motors of that size. The probable use of these motors required that the tests be made with the motor mounted vertically to reproduce later operating conditions.

It was necessary that the test stand be located in a remote, uninhabited, and relatively cleared-off area so that its operation would not constitute a fire hazard or a public nuisance and so that military security regulations, occasioned by the nature of the equipment to be tested, could be satisfied. With these restrictions on location it was further necessary to specify that the test station be readily accessible to trucks and other heavy equipment; that it be nearly self-sufficient under normal operating conditions, in the matter of shops and other auxiliary facilities; that electric power and water be available; and that accommodations for the operating personnel be located nearby.

The requirements for the complete test station included a test stand, shops, offices, propellant storage facilities, safety facilities (such as a fire system and access to medical aid), and all the equipment necessary to service and operate large-scale rocket motors and to record and analyze the data to be obtained from the tests.



### III. TEST STATION LOCATION AND FACILITIES

#### A. Location

A suitable location for the test station was found in the desert near Muroc, California, on the grounds of the Muroc Flight Test Base, ATSC. The test station is located approximately a mile from the nearest airfield installation, in the middle of the open desert (Cf Fig 1). Accommodations for the test crew are available at the Base, as are emergency fire fighting and medical assistance. Water and electric power are obtained from the base facilities. The location on a Government Reservation simplifies the security problem, as the entire area is patrolled and it is possible to secure special guards for the test stand when classified equipment is installed there.

#### B. Test Station Facilities

The test station at present has the following buildings and facilities:

1. The test stand proper, with motor mount, jet deflector, and propellant tank cells.
2. Control room, with all controls and instruments.
3. Combined office, shop, and photographic darkroom building with four rooms.
4. Propellant storage dock and air compressor shed.
5. Observation bulwark.
6. Auxiliary workshop with adjacent material storage racks.



7. Pump house for boosting water pressure for fire fighting.
8. Open storage shed.
9. Machine shop and welding shop trucks, supplied by the Ordnance Department and having unusually complete equipment.
10. Air compressor.

The arrangement of these facilities in the test station area is shown in Figs 1 and 2.

C. Test Stand

The test stand is made of reinforced concrete with a steel superstructure. Figures 3, 4, 5, and 6 show the test stand and the manner in which it is dug into the ground. The central feature of the stand is the 9-ft square vertical duct with the jet deflector at the bottom, 20 ft below the ground level (Cf Figs 4 and 6). The floor of the stand is approximately 4 ft above ground level. A 5-ton capacity chain hoist is mounted on a trolley approximately 20 ft above the floor and can be moved to cover the whole working area (Cf Fig 5). At one side of the central duct are three cells in which the propellant tanks and air pressure tanks are mounted (Cf Fig 7). Behind the stand is a deep, broad trench into which the jet motor blast is deflected by the curved carborundum brick lined surface at the bottom of the duct (Cf Figs 6 and 8). The motor mount base frame is bolted to the floor of the stand and supports the motor mount frame through 6 strain members, so that all 6 force components can be measured (Cf Figs 9 and 10). The motor

to be tested is mounted directly over the center of the duct and attached to the motor mount frame through the motor mount truss shown in Figs 9 and 10.

D. Control Room

The control room is a bombproof and gasproof reinforced concrete structure located 60 ft to one side of the test stand (Cf Figs 1, 2, and 11). This room, approximately 15 ft by 20 ft inside dimensions, has a front wall and a roof which are 1 ft thick, and a bulkhead door, which makes a gastight seal when it is closed (Cf Fig 12). There are five windows facing the test stand and one window in each end of the room. Each window has one pane of  $2\frac{1}{2}$ -in thick, 5-ply bulletproof glass and two panes of  $\frac{1}{4}$ -in thick duplate glass. The windows facing the stand are protected from large flying pieces by a grill of  $\frac{1}{2}$ -in steel rods mounted on the outside (Cf Fig 13).

The control room houses the test stand operators and the observers. In it are mounted the operators' control panel and the instrument panel for recording the data obtained from tests (Cf Figs 14 and 15). Electric and hydraulic lines running between the test stand and the control room are contained in a concrete lined trench which connects the two structures.

E. Office Building

The office building is 300 ft from the side of the test stand and directly behind the control house. It is of wooden frame construction

and is divided into four rooms as shown in Figs 16 and 17. The two large rooms are used for shop and office work, respectively, and the two small rooms (one, a darkroom) are for the use of the photographer (Cf Figs 18, 19, and 20).

F. Propellant Dock

The propellant dock is located across the roadway from the control room, and has a partition separating the areas to be used for oxidizer storage and for fuel storage (Cf Fig 21). Beside the dock is a three-walled shed which houses the air compressor used to charge the propellant pressurizing tanks (Cf Fig 22). All propellant filling operations are performed from the dock. Three pipe lines carrying, respectively, air, oxidizer, and fuel, run underground from the dock and shed to the test stand tank cells.

G. Observation Bulwark

The observation bulwark is located approximately 150 ft from the test stand and to one side of a line between the test stand and the control house. It is an open-back structure of reinforced concrete and has two windows similar to those in the control house (Cf Fig 23). This bulwark is intended for the protection of persons who wish to observe the testing but are not concerned with the operation of the unit or the observation of data-recording instruments.

H. Auxiliary Workshop

The auxiliary workshop is at the end of the road beside the test stand. It is intended to be used while installations are under way,



and has no permanently installed tools. Beside this building are material storage racks for lengths of pipe, tubing, and other metal stocks (Cf Figs 23 and 24).

I. Pump House

The pump house contains water pumps and a surge tank for the water system (Cf Figs 25 and 26). Water is supplied from the Flight Test Base through a pipe line and pumped to 50 psi pressure for use at the test station. A 200 gal/min standby pump is provided for use in case of fire.

From the pump house the water line runs down past the office building to the test stand. Outlets for 1½-in fire hose are provided at convenient intervals for fire fighting purposes, and three shower heads are provided for the use of personnel splashed by propellant (Cf Figs 17 and 24).

J. Machine Shop and Welding Shop Trucks

These two trucks were made available for 6 months by the Ordnance Department. The welding truck is equipped with an arc welding outfit driven by a gasoline motor generator set, a power hacksaw, a grinder, a gas welding outfit, an anvil, a forge, and many smaller items. The welding truck has been able to meet all the needs for this type of equipment encountered during the construction and installation phase of the test station program.



The machine shop truck is equipped with a lathe, a shaper, a drill press, a grinder, and many smaller machinists' tools. It, likewise, has proved indispensable during the initial development of the test station. Figure 27 shows these two trucks in operation.

K. Air Compressor

The air compressor is such a large and important item of equipment that it deserves separate mention. It is used to pump air under high pressure into the air tanks, from which it is later delivered through a pressure regulator to pressurize the propellant in the propellant tanks.

The unit consists of an Ingersoll Rand compressor capable of pumping 72 cu ft/min of free air to a pressure of 3000 psi. It is belt driven by a Waukesha gasoline engine mounted on the same base frame. The entire unit is mounted on a trailer so that it can be towed to the region where it is to be used. The trailer and compressor unit are stored in the compressor shed at the Muroc test station in order to protect the machinery from the wind and sand prevalent at that location (Cf Figs 21 and 22).

L. Air and Propellant Tanks

The high pressure air reservoir used to supply air at regulated pressure to the propellant tanks consists of 8 tanks manifolded together. Each tank is 16 $\frac{1}{2}$  ft long, 11  $\frac{3}{4}$  inches in outside diameter, has an internal volume of 8  $\frac{3}{4}$  cu ft, and bears an ASME Unfired Pressure

Vessel code label certifying that it can be used with an internal working pressure of 2500 psi (Cf Fig 28). The 8 tanks are mounted around the walls of the cell and manifolded, as shown in Figs 7 and 29. Provision is made for blanking off one side of the manifold if the use of only 4 tanks at one time is desirable.

The oxidizer tank is hung from a strain gauge support in the cell next to the air tanks (Cf Fig 7). It is made of 18-8 stainless steel and has a working volume of 617 gallons and a cylindrical shell length of 12 ft 5 in (Cf Fig 30).

The fuel tank is similar to the oxidizer tank. It is fabricated of 1020 steel plate, with a 30-in outside diameter, a cylindrical shell length of 11 ft, and a working volume of 367 gallons. It is hung in a cell adjacent to the acid tank cell (Cf Figs 7 and 31).

Both propellant tanks bear ASME Unfired Pressure Vessel code labels certifying that they can be used with a working pressure of 600 psi.

#### IV. FLOW AND CONTROL CIRCUITS FOR LIQUID-PROPELLANT ROCKET MOTOR TESTS WITH AIR PRESSURE PROPELLANT FEED SYSTEM

The basic circuit diagram for a liquid-propellant rocket motor with gas pressure propellant feed system is shown in Fig 32. Figures 33, 34, and 35 show in detail the circuits as installed at the ORDCIT Test Station, Muroc. Figure 33 shows the propellant circuit with auxiliaries such as motor flush, tank pressure vent, and all the instrumentation connected with this circuit. Figure 34 shows the air pressure system for pressurizing the

propellant, and Fig 35 shows the hydraulic system used for actuating the valves in the other propellant and air circuits.

The control switches and the instruments are located in the control room 60 ft from the motor test stand. Control is exercised by operating switches which actuate the solenoid valves, admitting hydraulic fluid to the actuating cylinders of the various valves. Colored lights on the control panel indicate to the operator the position of the various switches. The electrical circuit diagram of the control system is shown in Fig 36.

Most of the pressure and all of the force measurements are taken from transmitting units utilizing resistance strain gauge elements. The amplifiers and indicating milliammeters for these circuits are located in the control room. Figures 36 and 37 show the electrical circuit diagram for this system (Cf Appendix A). In addition, use is made of GE Selsyn units to indicate the position of the rotary plug valves in the main propellant lines, and Bourdon tube pressure gauges are used to indicate the air pressure in the governing pressure circuit leading to the air pressure regulator.

All of these indications appear on the instrument panel, and each instrument is photographed by two cameras. The cameras are on different circuits to minimize the chance of failure to get a record of the test data (Cf Fig 15). The layout of the instrument panel is shown in Fig 38.

On the control panel, above the switchboard, is an instrument panel on which certain indications necessary for the guidance of the operator are reproduced. Figures 39 and 40 show the position of the controls and



instruments on the control panel and also the system of colored indicator lights used to assure the operator of the condition of his electrical control circuits.

## V. TEST STAND INSTRUMENTATION

### A. Forces and Weights

The motor mount is designed to measure 3 components of thrust and 3 components of side force. This is accomplished by using 6 strain gauge units arranged between the base frame and the motor frame as shown in Figs 9 and 10. Figure 9 shows the space layout of the strain gauge units and gives the dimensions needed to obtain the moments from the force measurements. Each resistance-type strain gauge unit is connected to an amplifier and a milliammeter as shown in Figs 36, 37, and 38 and described in Part IV and Appendix A.

The two propellant tanks are hung from strain gauge units similar to those used to measure thrust. Figure 41 shows the way in which the tank support is arranged with universal joints at the ends of the strain gauge units and with two safety bolts to take the load when the strain gauge unit is removed.

A typical strain gauge unit for the motor forces is shown in Fig 42, and the unit for the tank support is shown in Fig 43. The wiring diagram for the resistance-type strain gauge elements applied to these units is given in Fig 37.



B. Pressures

Pressures are measured with diaphragm-type units utilizing resistance strain gauge elements (Cf Figs 44 and 45). These units are made of stainless steel to resist acid corrosion and are placed near the source of the pressure to be measured. Their use makes it possible to obtain remote indication in the control room of pressures from the test stand area and also to measure pressures which would not be permissible in the control room, either because of magnitude or because of the nature of the substance under pressure.

C. Propellant Consumption

In addition to the strain gauge tank supports, which give a continuous indication of propellant consumption, a sight glass connected to each propellant tank permits measurement of the total propellant consumption during each test (Cf Fig 46). In order to make this possible the tanks and sight glasses were calibrated by filling each tank with water and weighing the water as it was withdrawn.

D. Temperatures

Temperatures at the test stand can be measured by means of thermocouple elements. A Brown Indicating Potentiometer with a range of 0 to 10 millivolts or 0 to 45 millivolts is available for observing the thermal data (Cf Fig 47). This instrument responds rapidly, and readings on separate thermocouples can be obtained with time intervals between readings of no more than 4 sec.

E. Calibration

Equipment is available to calibrate the instrumentation described above. Force measuring units are calibrated by applying loads through proof rings by hydraulic jacks. Two proof rings are on hand; one with a maximum load of 5000 lb and the other with a maximum load of 25,000 lb (Cf Fig 48). These proof rings were manufactured by the Morehouse Machine Co. of York, Pennsylvania, and were supplied with individual Bureau of Standards calibrations. Each proof ring can be read to within 1/10 of one per cent of its capacity load. Two hydraulic jacks of 8 and 12 ton capacity, respectively, are available for applying loads to these compression-type proof rings.

Pressure gauges can be calibrated with an Amthor Dead Weight Tester with a range from 0 to 2500 psi (Cf Fig 49). This instrument is accurate to within 1/10 of one per cent indicated pressure.

A Fairbanks Morse platform scale is available for weight measurements (Cf Fig 50). This scale has a 300-lb capacity and is graduated in 1/100-lb divisions.

VI. TEST STAND AND CIRCUIT EQUIPMENT

Figures 51 through 63 show some of the special equipment installed in the circuit and the motor balance system. They supplement some of the preceding drawings in the report and provide data needed in the servicing of some of the equipment.

APPENDIX A

ADJUSTMENT AND CALIBRATION OF STRAIN GAUGE EQUIPMENT

The body of this report has described the use of resistance strain gauge units for the measurement of forces on the test frame (Cf Fig 42), weights of the propellant tanks (Cf Fig 43), and pressures (Cf Fig 44). The active parts in each of these units are Baldwin SR 4 type 4 resistance strain gauges which are mounted on members of a size and shape appropriate to the magnitude being measured. Electrically each unit consists of four 120-ohm strain gauges connected in a Wheatstone bridge. Two of the gauges are mounted at points of maximum positive stress and are connected in opposite arms of the bridge while the remaining gauges are mounted at points of greatest negative stress and provide the other bridge arms. Thus, since all bridge arms are mounted near each other, satisfactory temperature compensation is obtained. The input to this bridge is 6 volts, 60 cycle A. C., and the output at nominal mechanical load is approximately 5 millivolts into a high resistance. This signal is amplified and fed to a milliammeter which is then photographed.

The amplifiers used consist of three resistance coupled triode stages followed by an A. C. powered vacuum tube voltmeter which is sensitive only to voltages in phase with its plate supply. This complete circuit is capable of delivering 1 milliamperes output for an input of approximately 2 millivolts. No departure from linearity is observed when the circuit is properly adjusted. These amplifiers are mounted in groups of 6 on standard relay rack chassis



which are placed in a shock-mounted frame. Another chassis in the same rack provides the necessary A. C. and D. C. voltages for the amplifiers and a constant voltage source for the strain gauge input power. With this arrangement very little trouble is experienced as a result of line voltage fluctuations.

Controls provided are: (1) a screwdriver adjustment for balancing the vacuum tube voltmeter (adjusted very infrequently); (2) a resistance balance control to compensate for variations in the resistance of the gauge units; (3) a gain control to adjust the range of the indicating instrument. No reacting balance is necessary.

To check the amplifier control settings before use, a switching circuit is provided to place a fixed calibrating resistor across one arm of the strain gauge bridge, thus unbalancing the bridge and producing an output voltage equal to that produced by a certain mechanical magnitude. During calibration of each unit a correlation between output with calibrating resistor and output with force or pressure is developed and tabulated. This "mechanical equivalent" is invariant within experimental error and hence provides a convenient check on amplifier gain settings.

The actual adjustment technique is then:

1. Allow amplifiers to warm up approximately 15 min; bring all measuring units to zero.
2. Adjust balance controls for zero meter readings.

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3. Switch appropriate calibrating resistor into circuit, and adjust gain control to produce desired deflection (computed from required full-scale reading and mechanical equivalent of resistor).
4. Recheck steps 2 and 3.

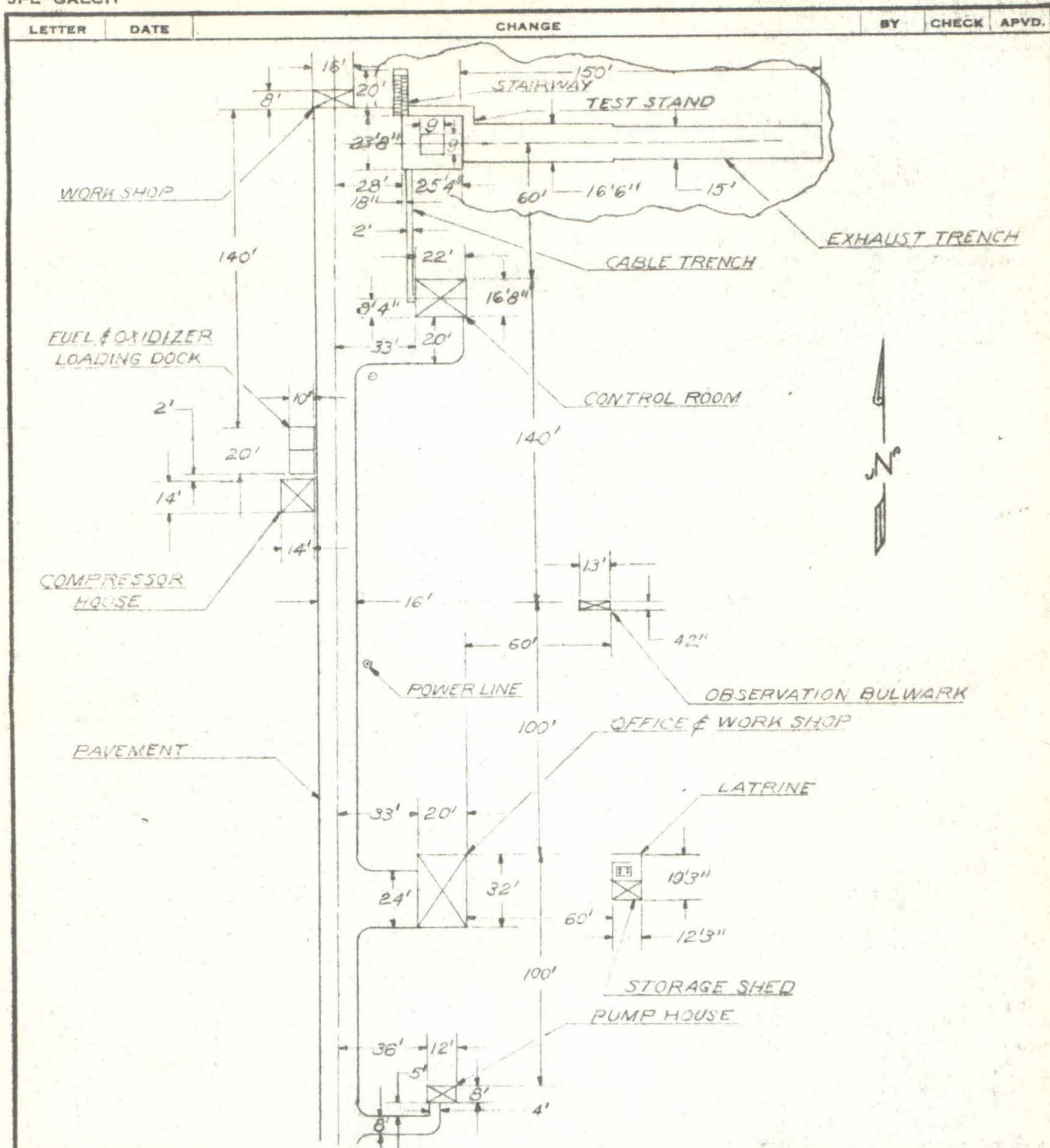
After these adjustments are made, there is no significant drift in periods as great as  $\frac{1}{2}$  hour, but the stability of the units for periods longer than this is considered questionable.

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Fig 1. View of the Test Station in the Desert  
near Muroc, California.





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SECTION

PROJECT CLASSIFICATION

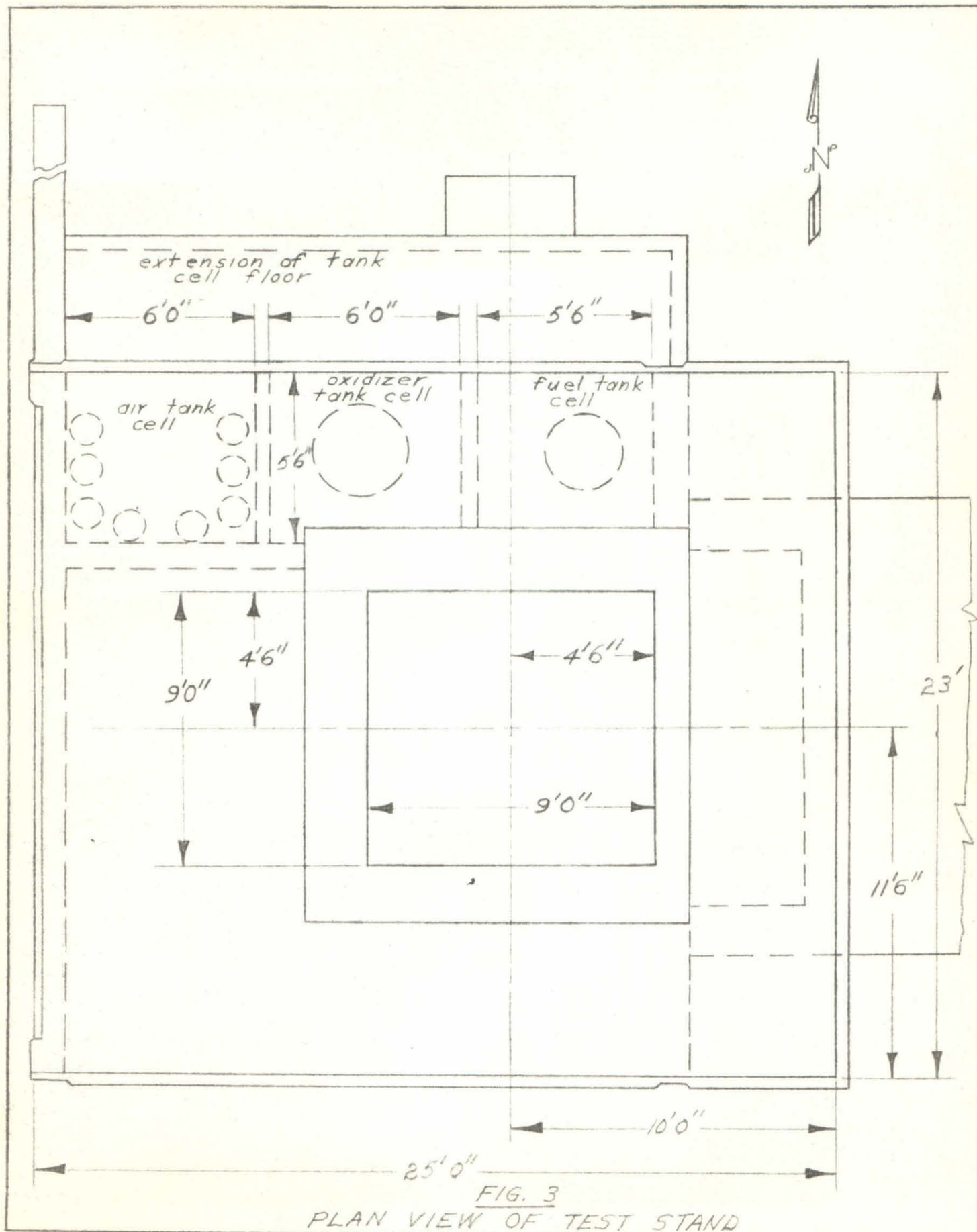
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DES.	MATERIAL	SCALE 1"=60'	WEIGHT
DWN. <i>Blackburn 8/21/45</i>		ENG. EXAM. PROD. EXAM.	PART TOOL
CHK.			
APPD.			
ENG.			

PLAN

ORDCIT MUROC TEST STATION

DRAWING NO.





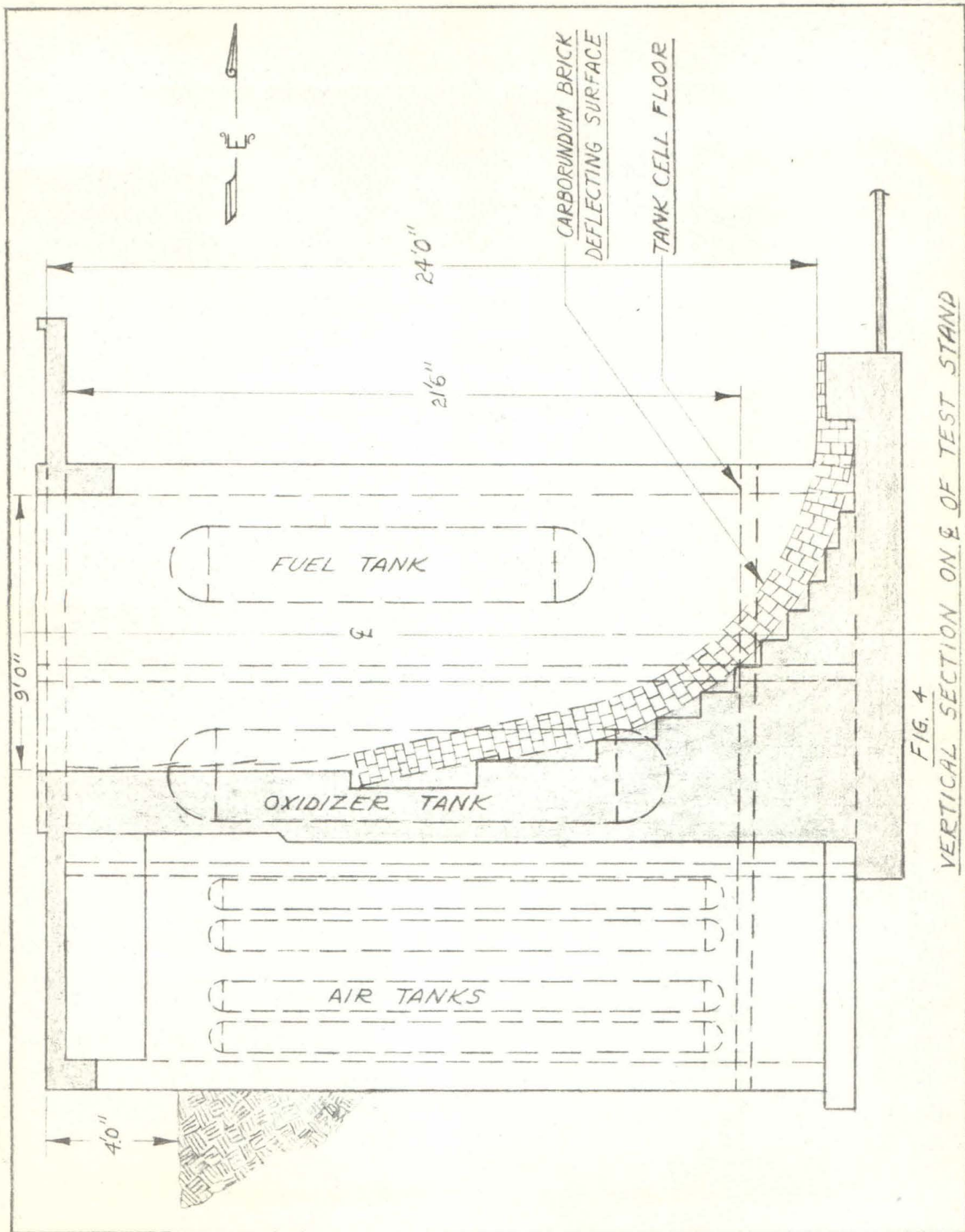


FIG. 4  
VERTICAL SECTION ON & OF TEST STAND





Fig 5. Front View of the Test Stand.



Fig 6. Rear View of the Test Stand Showing Jet  
Deflector Duct and Open Trench.



Fig 7. Side View of the Test Stand Showing Air and Propellant Tanks Mounted in Cells Below Ground Level.





Fig 8. View of Open Trench Behind the Test Stand.



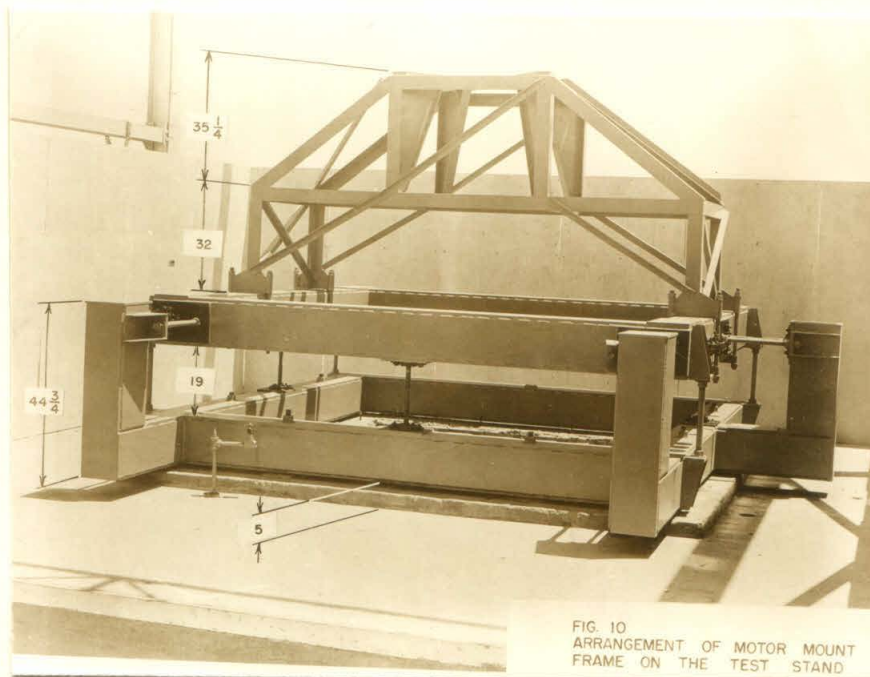


Fig 10. Arrangement of Motor Mount Frame on the Test Stand.





Fig 11. View Showing Control Room Located 60 Ft  
from the Test Stand.

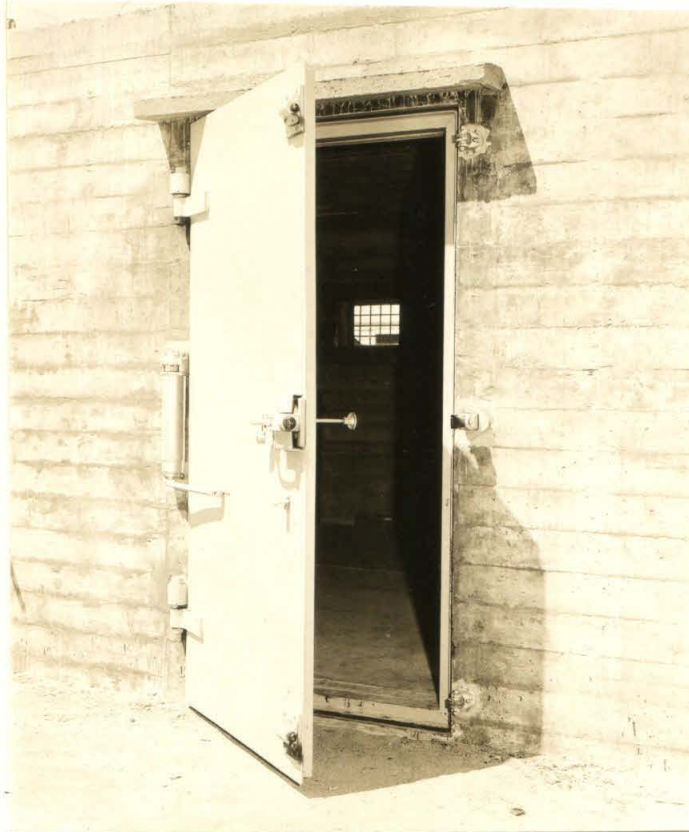


Fig 12. The Bulkhead Door of the Control Room.

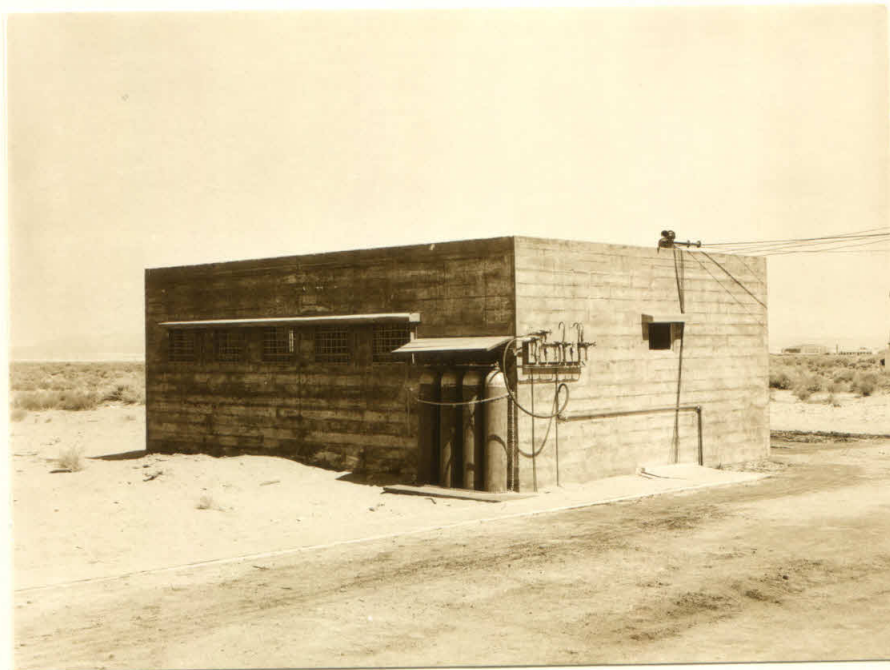
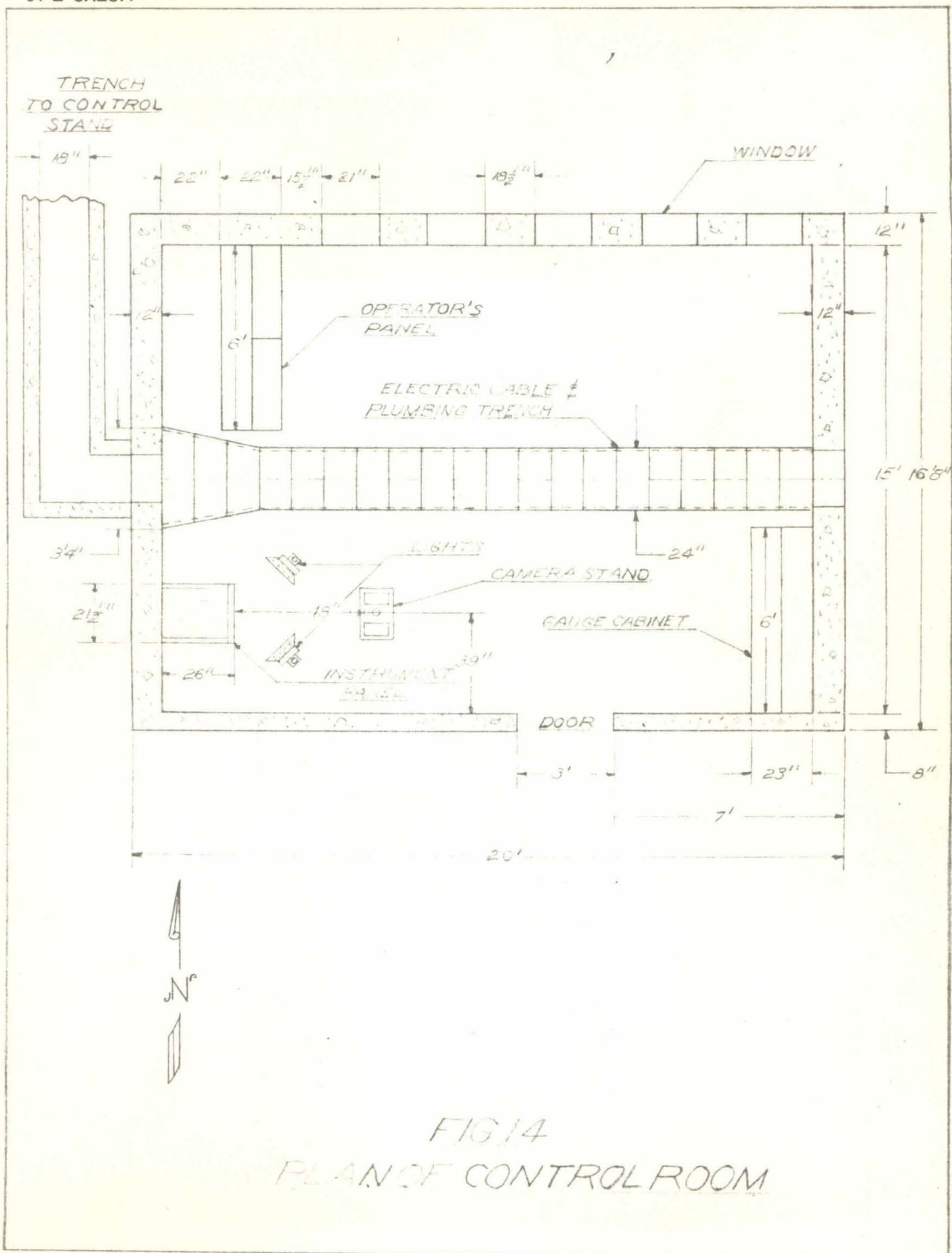


Fig 13. The Control Room Showing Grills over Windows  
Facing the Test Stand.





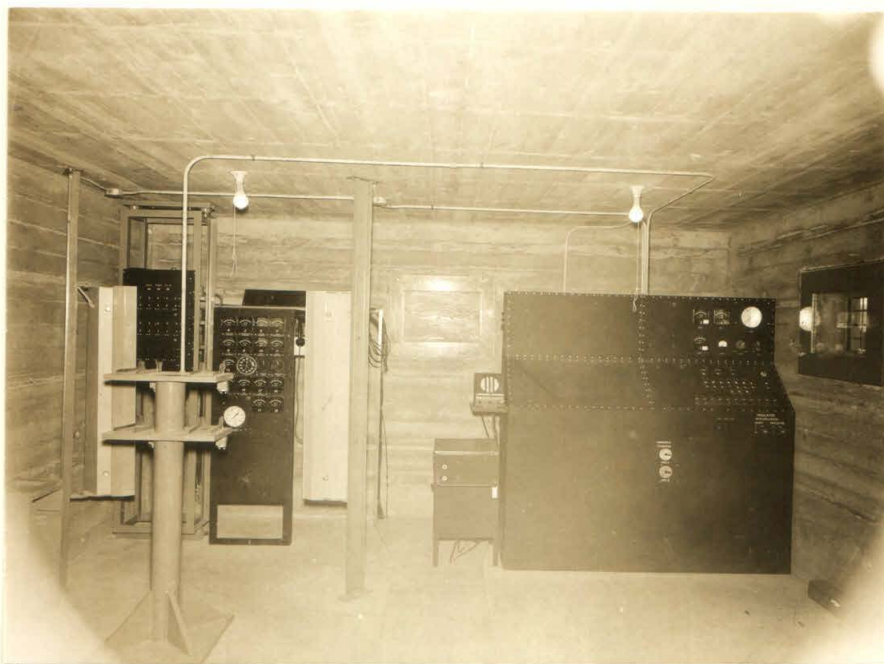


Fig 15. The Interior of the Control Room.

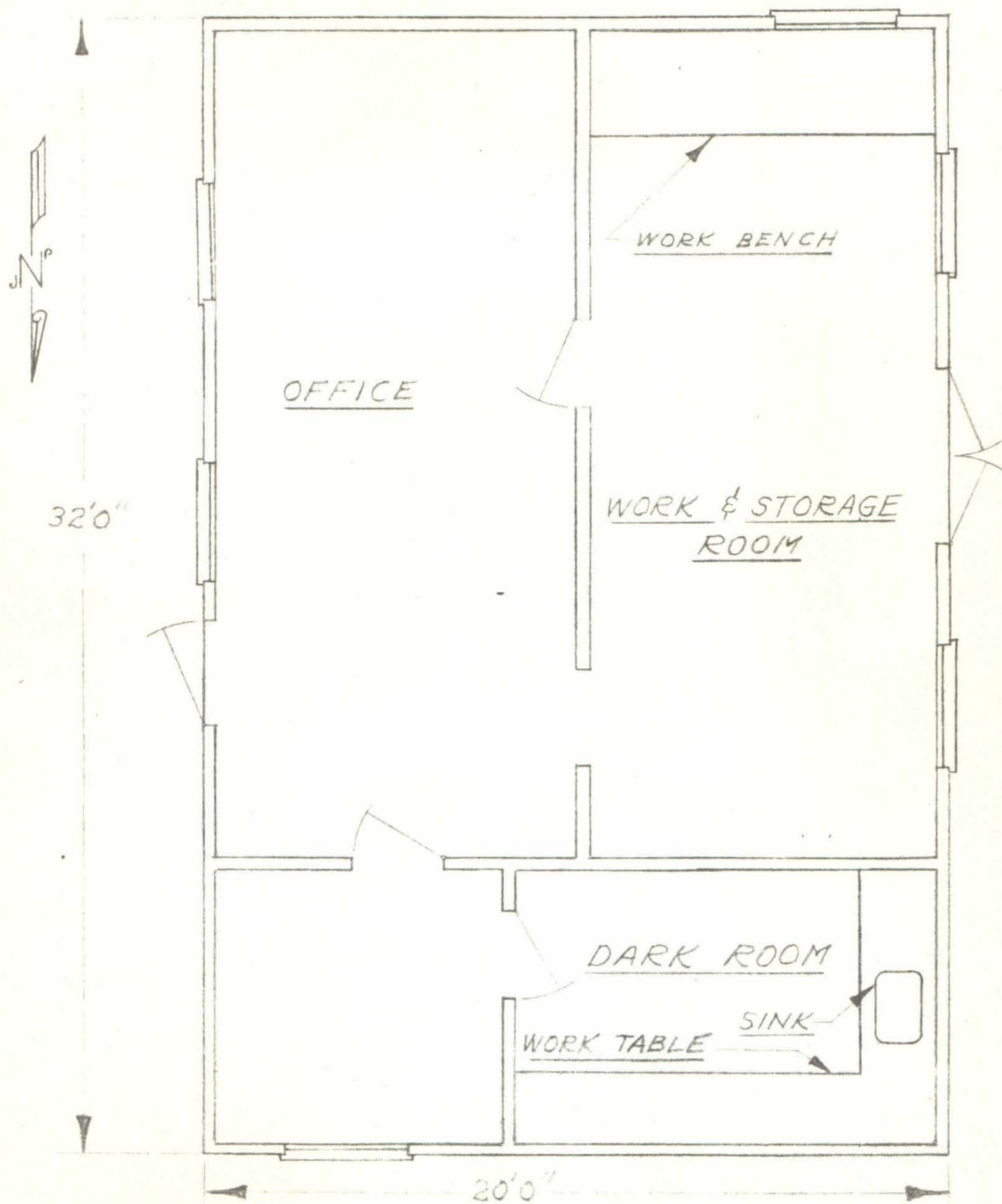


FIG. 16

PLAN OF OFFICE BUILDING





Fig 17. The Office and Shop Building.

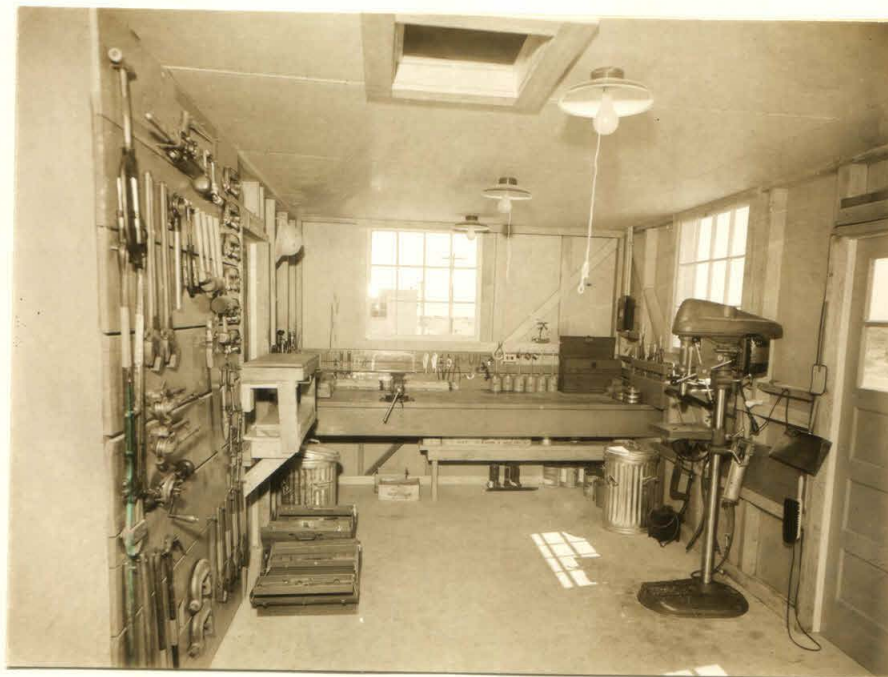


Fig 18. The Interior of the Shop Room.



Fig 19. The Interior of the Office Room.





Fig 20. The Interior of the Photographic Laboratory.



Fig 21. The Propellant Loading Dock and the Air Compressor Shed.

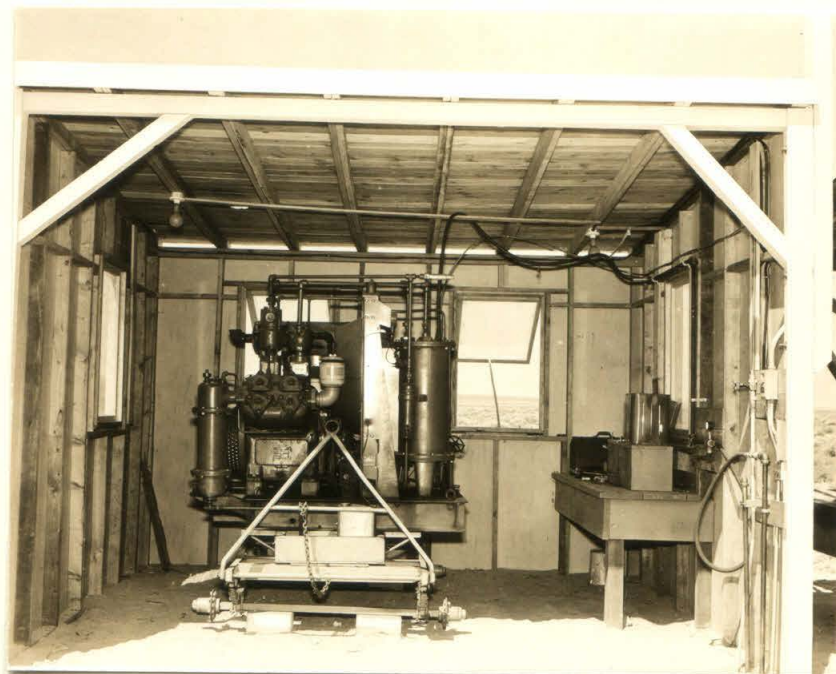


Fig 22. The Air Compressor Mounted in Its Shed.





Fig 23. View Showing the Observation Bulwark in the Foreground  
and the Control Room and Test Stand in the Background.



Fig 24. The Auxiliary Workshop and Material Storage Racks  
as Viewed from the Test Stand.



Fig 25. The Pump House Showing the Surge Tank.





Fig 26. The Interior of the Pump House.

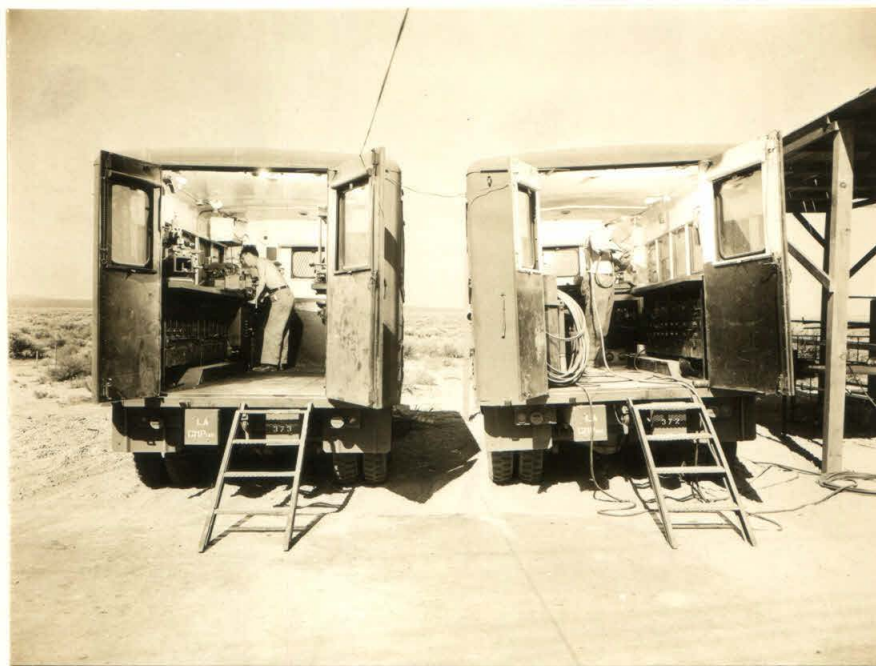


Fig 27. The Machine Shop Truck and the Welding Truck in Operation.

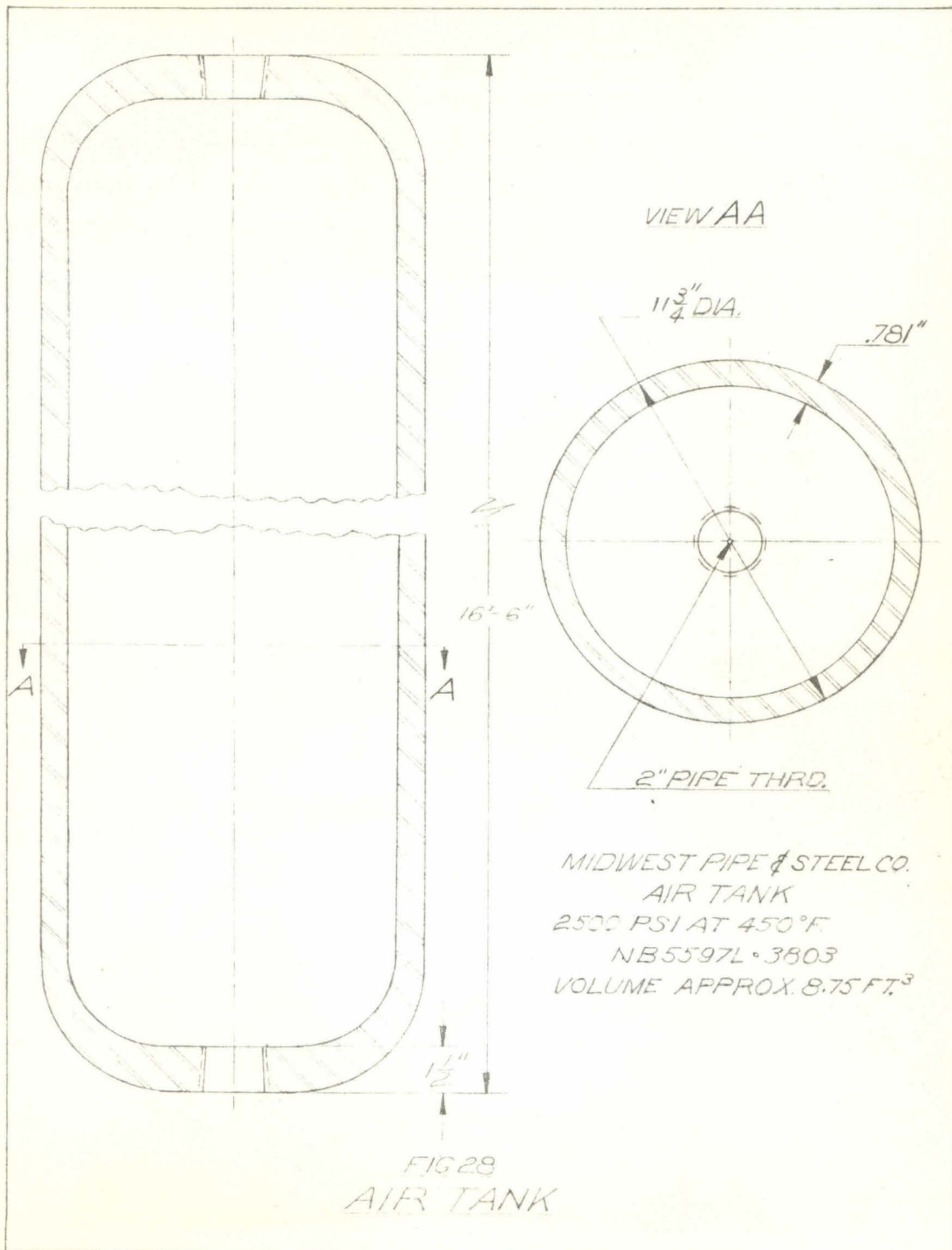
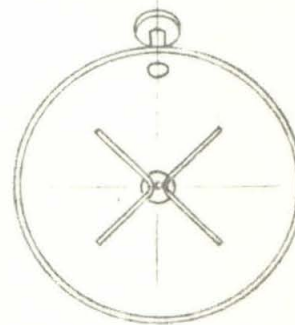
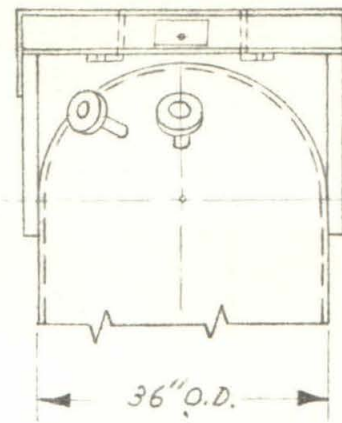
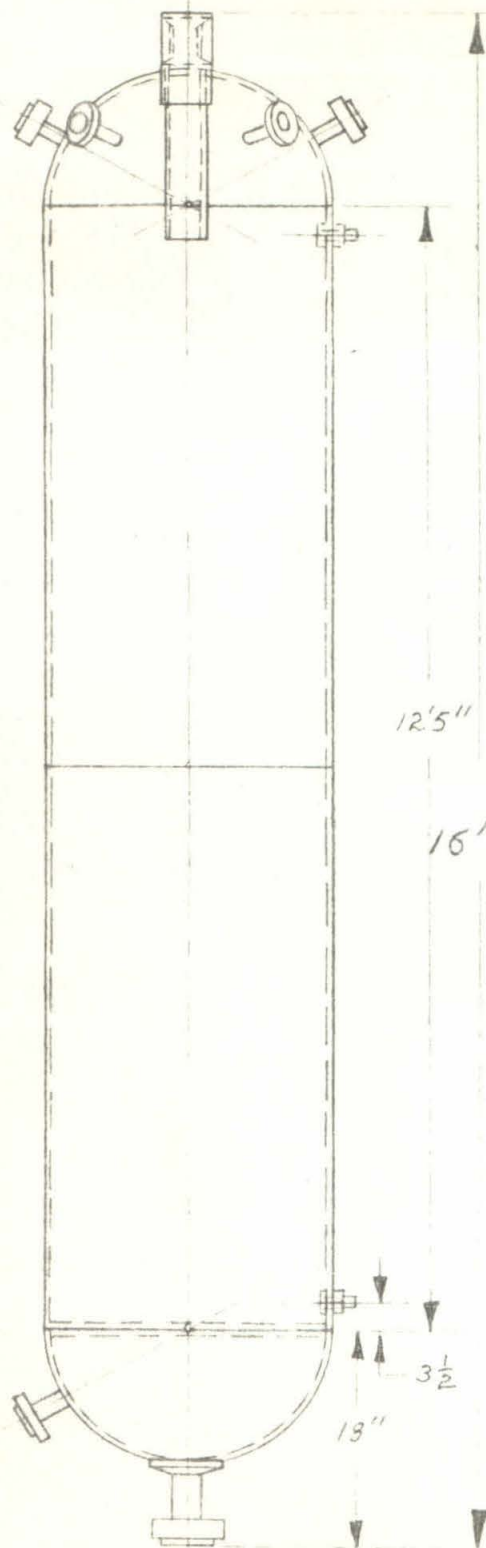






Fig 29. The Air Tank Manifold Showing Air Valve and Pressure Regulator Mounted.



SECTION A-A

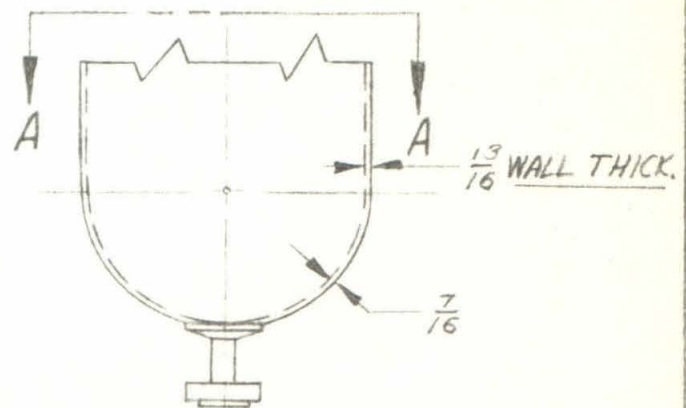
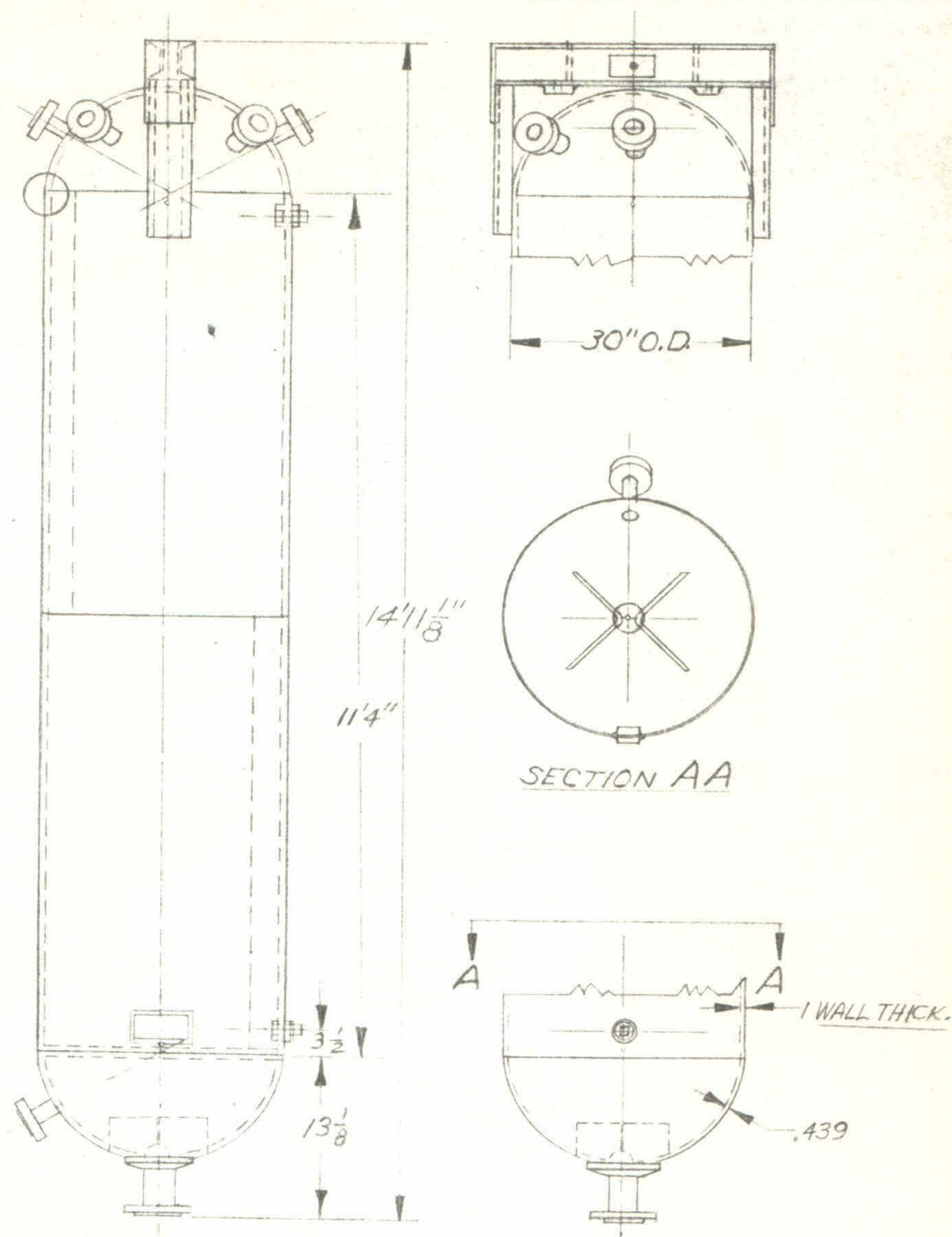


FIG. 30  
OXIDIZER TANK

(REF.: CONSOLIDATED  
STEEL CO. DWG.:  
2329-269)



NOTE: FOR REF. CONSOLIDATED STEEL CO. DWG. 2329-268

FIG.31  
FUEL TANK



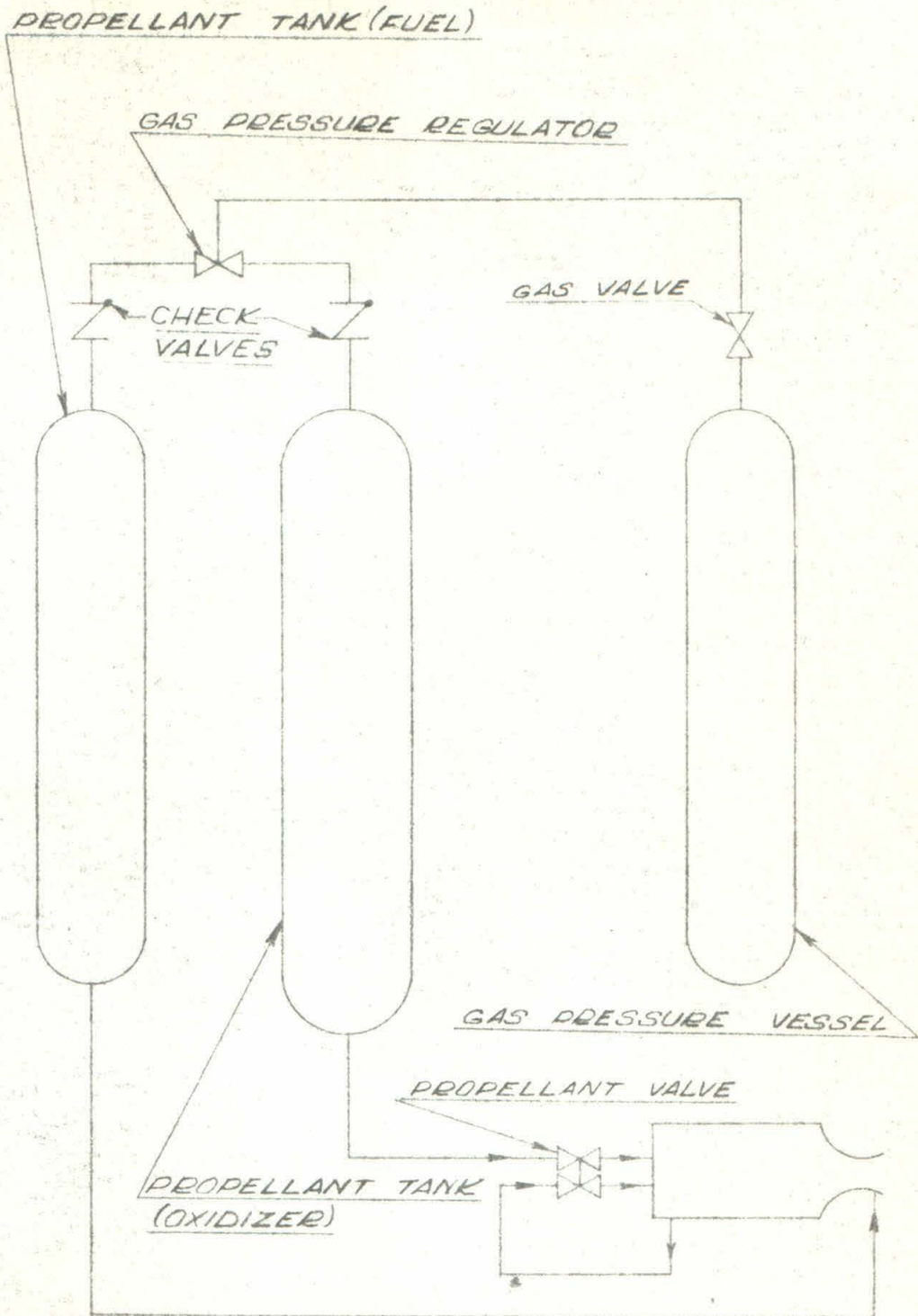
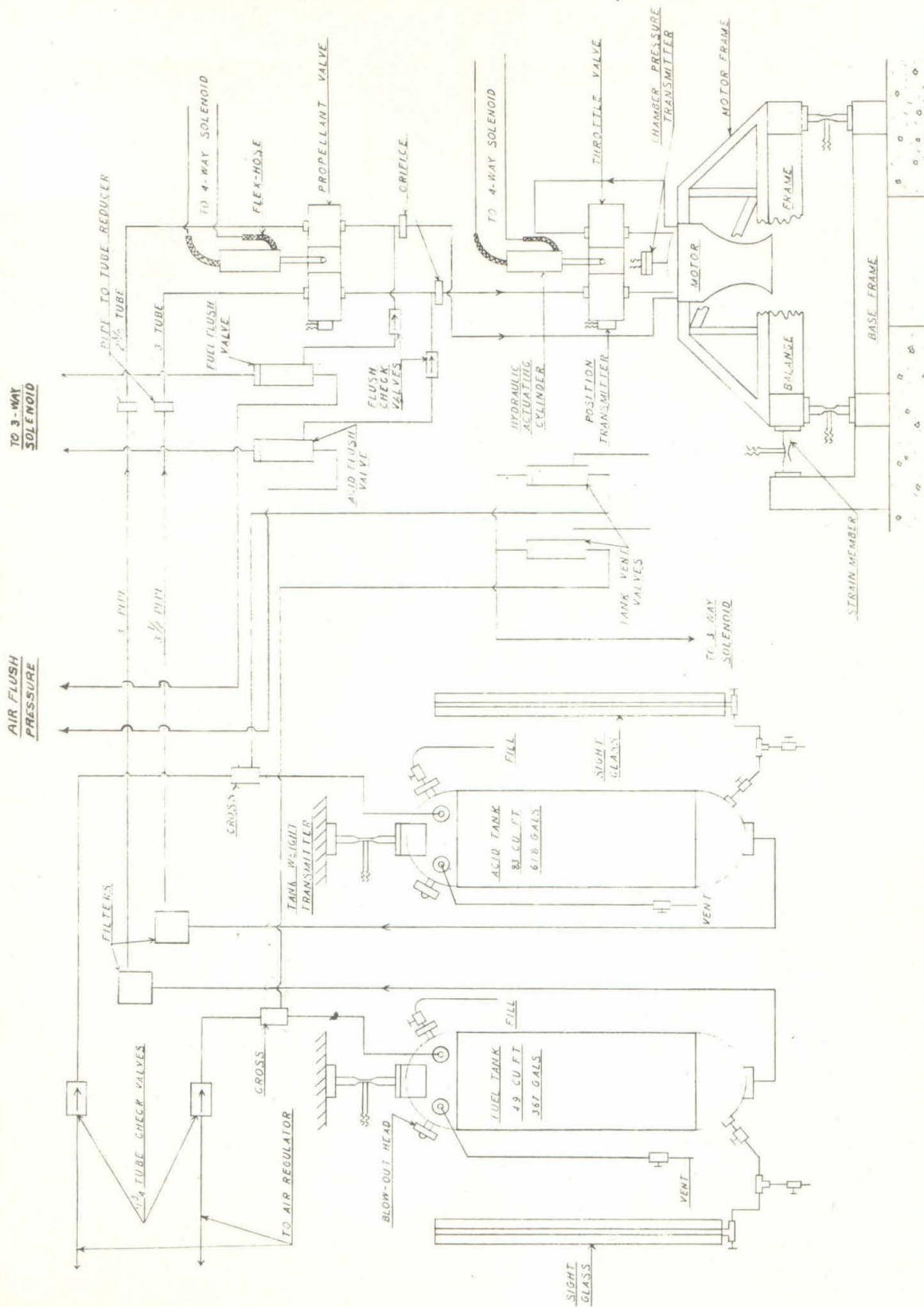
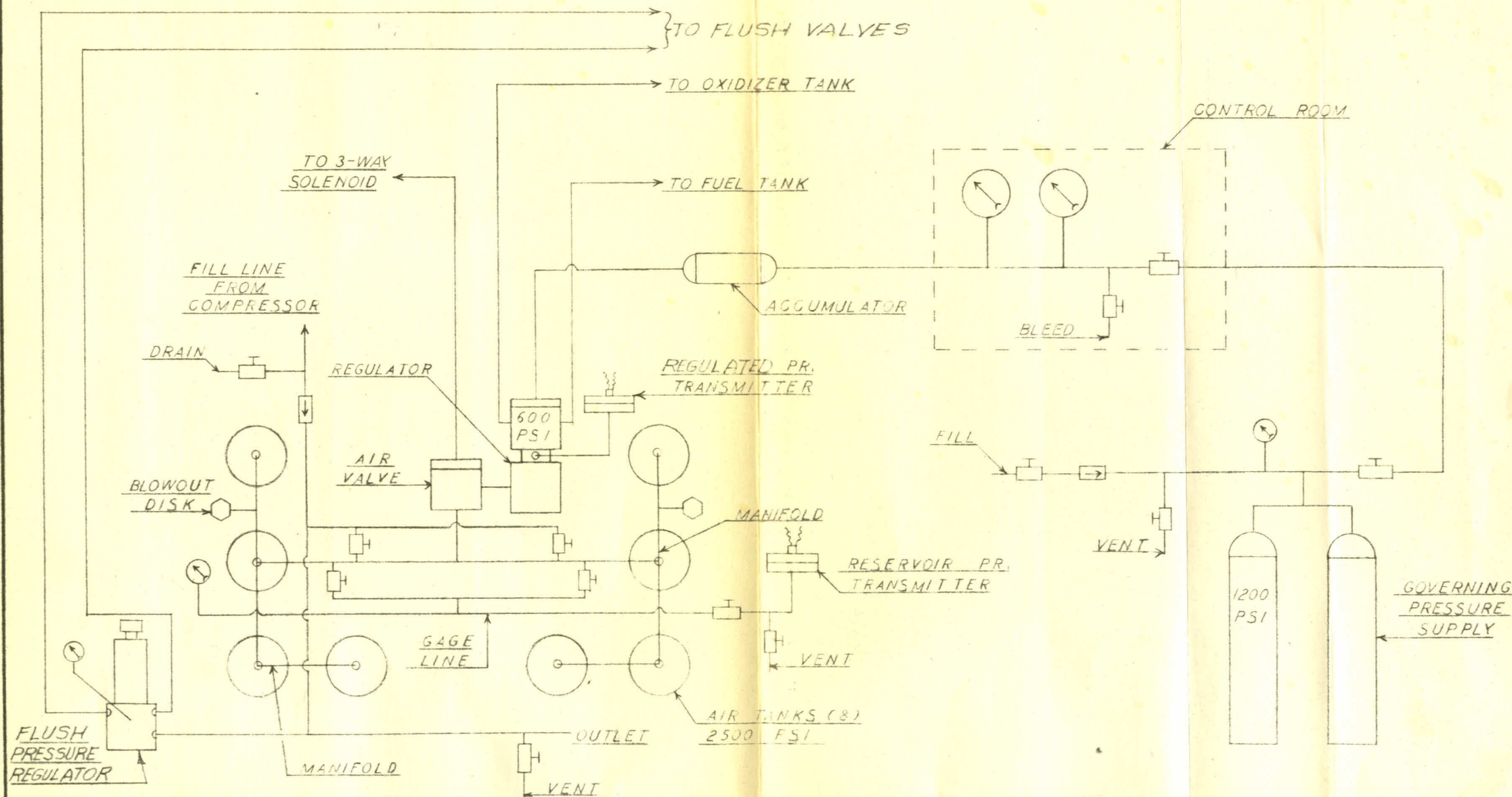


FIG 32 BASIC CIRCUIT DIAGRAM FOR A LIQUID PROPELLANT  
ROCKET MOTOR WITH GAS PRESSURE PROPELLANT  
FEED SYSTEM.



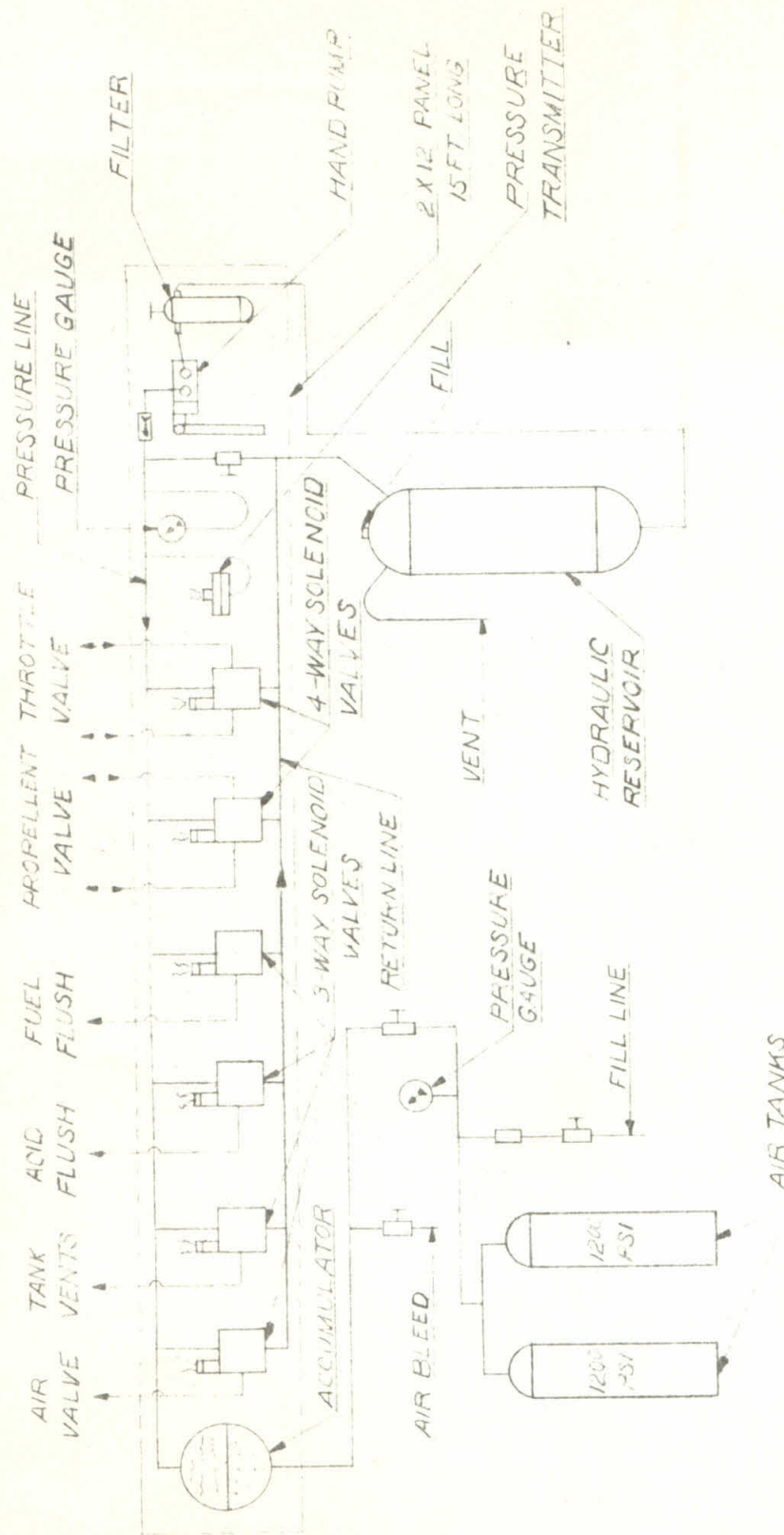
JET PROPULSION LABORATORY, GALCIT		CALIFORNIA INSTITUTE OF TECHNOLOGY	
PROJECT DESIGNATION		SECTION	
<p>This document contains information affecting the National Defense of the United States within the meaning of Espionage Act, U.S.C. 56-31 and 56-32, the transmission or the revelation of its contents in any manner to an unauthorized person is prohibited by law.</p>			
DES.	DWN.	CHK.	APP.
MATERIAL			
PROPELLANT CIRCUIT			
FIG. 33			
DRAWING NO.			





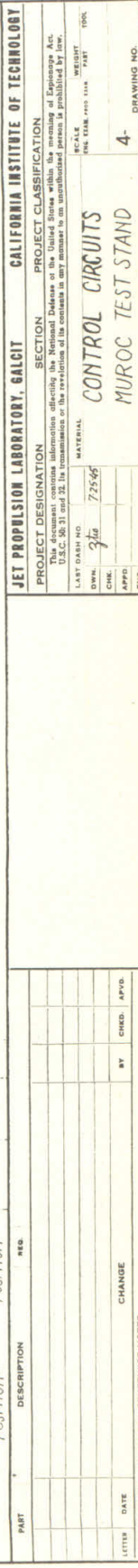
PART			DESCRIPTION			REQ.		



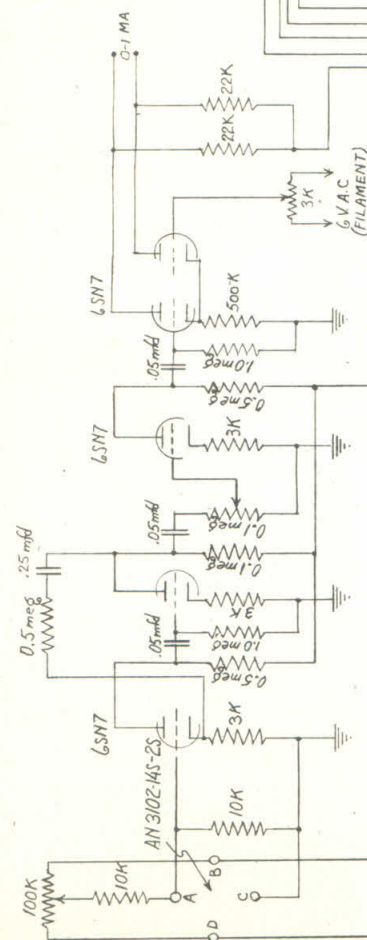
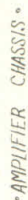


NOTE: SOLENOIDS ARE OPERATED  
BY 24 VOLTS D.C.

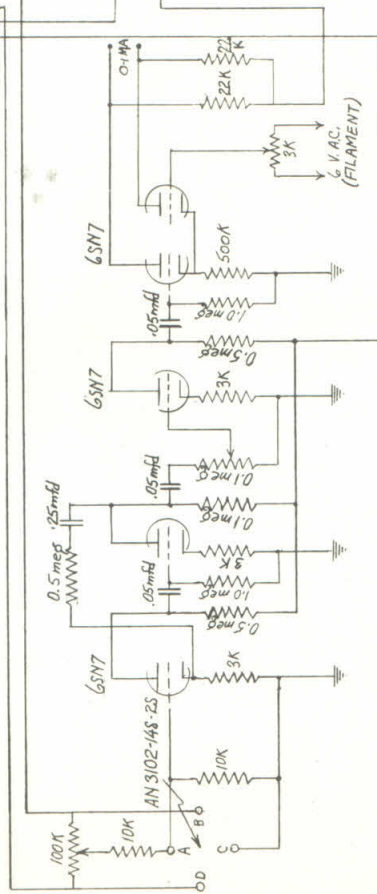
FIG. 35  
HYDRAULIC CONTROL SYSTEM



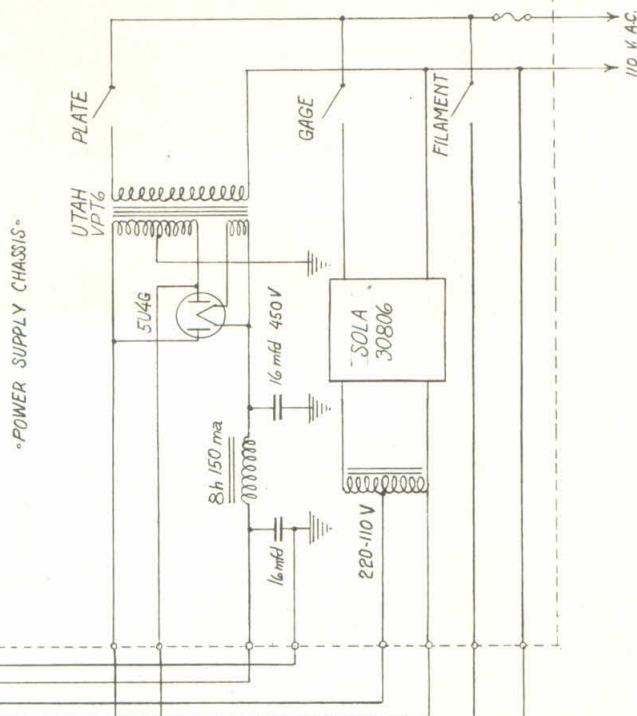
- 1. 6 CHANNELS PER CHASSIS.
- 2. POWER SUPPLY COMMON UP TO 5 CHASSIS.



CHANNEL - 1



CHANNEL-2



PEERLESS 8520A

6V-FILAMENT

FIGURE NO.	DATE	BY	CHG'D.	APPR'D.	DESCRIPTION	REV.
1						

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PROJECT DESIGNATION		SECTION	
This technical drawing is the property of the California Institute of Technology. Any unauthorized reproduction or use of this drawing without the written permission of the U.S.C. 561-21-22. In transmission of this drawing the contents in our possession is prohibited by law.			
LAST DASH NO.		MATERIAL	
DRAWN:	7-26-75		
CHEK:			
APPR'D:			
SCALE		WEIGHT	
NEW SCALE: NONE		PART	
4-		DRAWING NO.	

STRAIN GAUGE AMPLIFIER UNIT





Fig 38. The Instrument Panel in the Control Room.

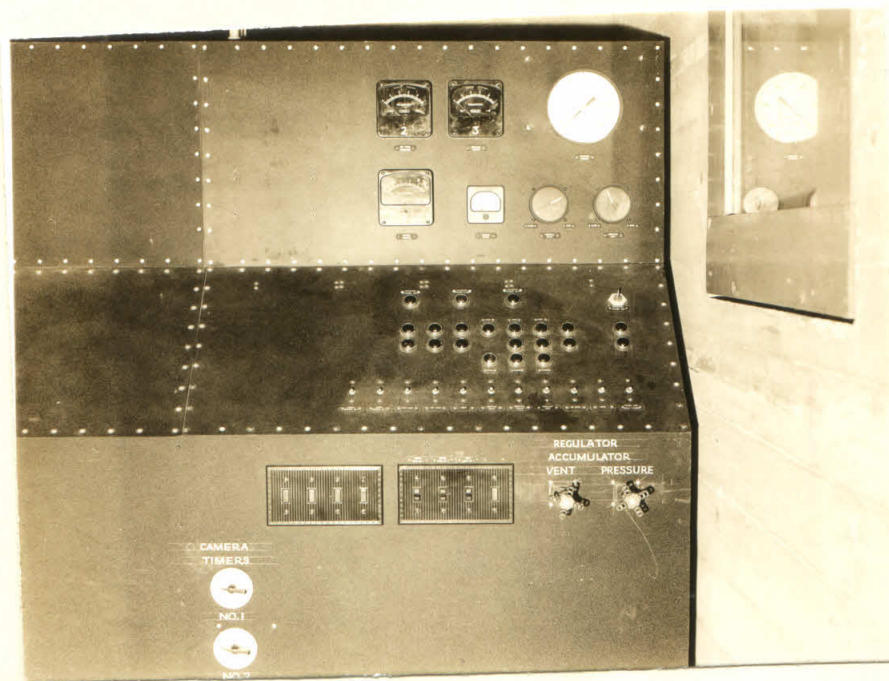


Fig 39. The Control Panel.

**FIG. 40**  
**CONTROL PANEL OPERATING GUIDE**



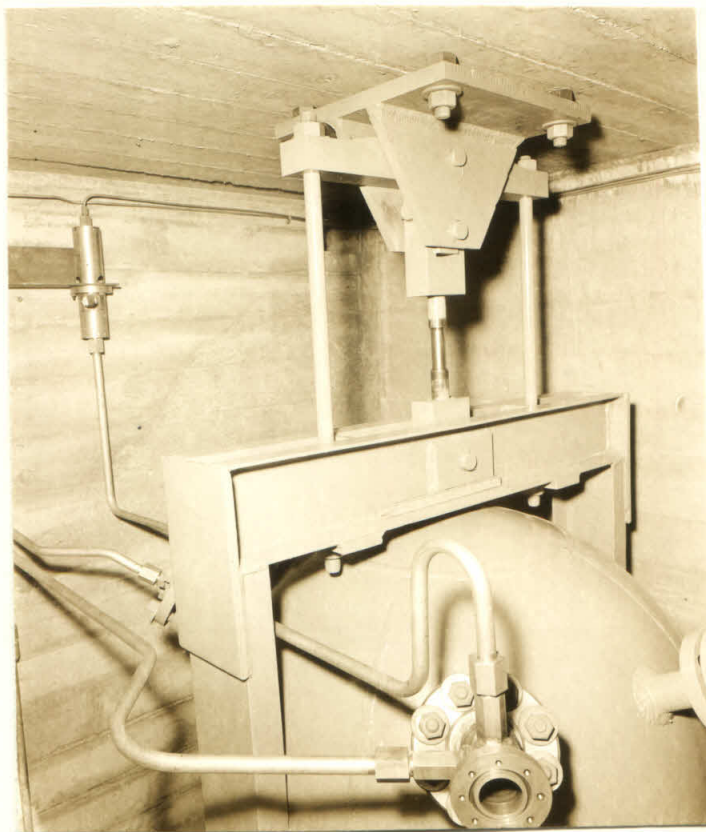


Fig 41. Propellant Tank Hanger Showing Strain Unit with Universal Joint at Each End and Two Safety Bolts.

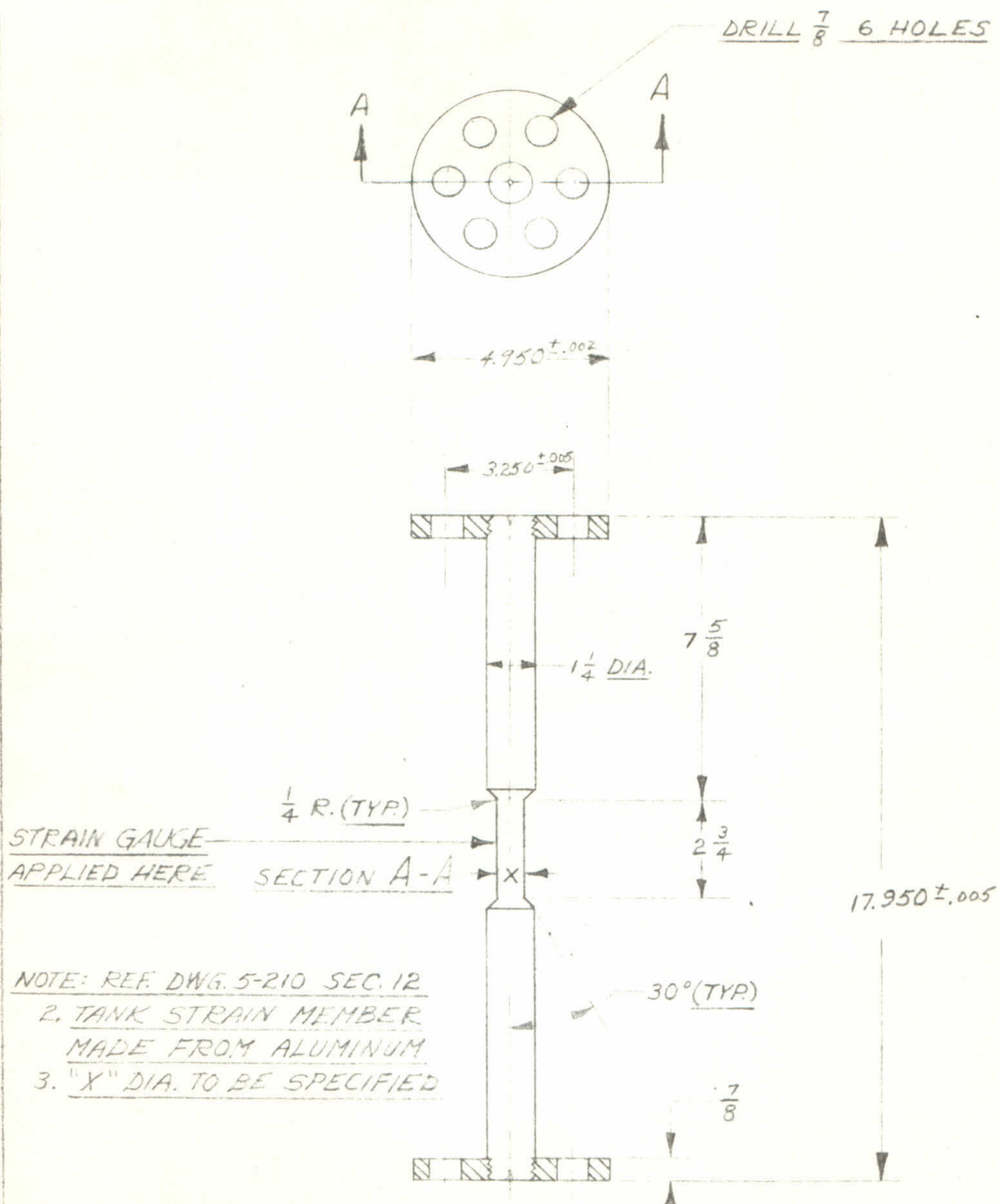


FIG. 42  
MOTOR FORCE STRAIN MEMBER

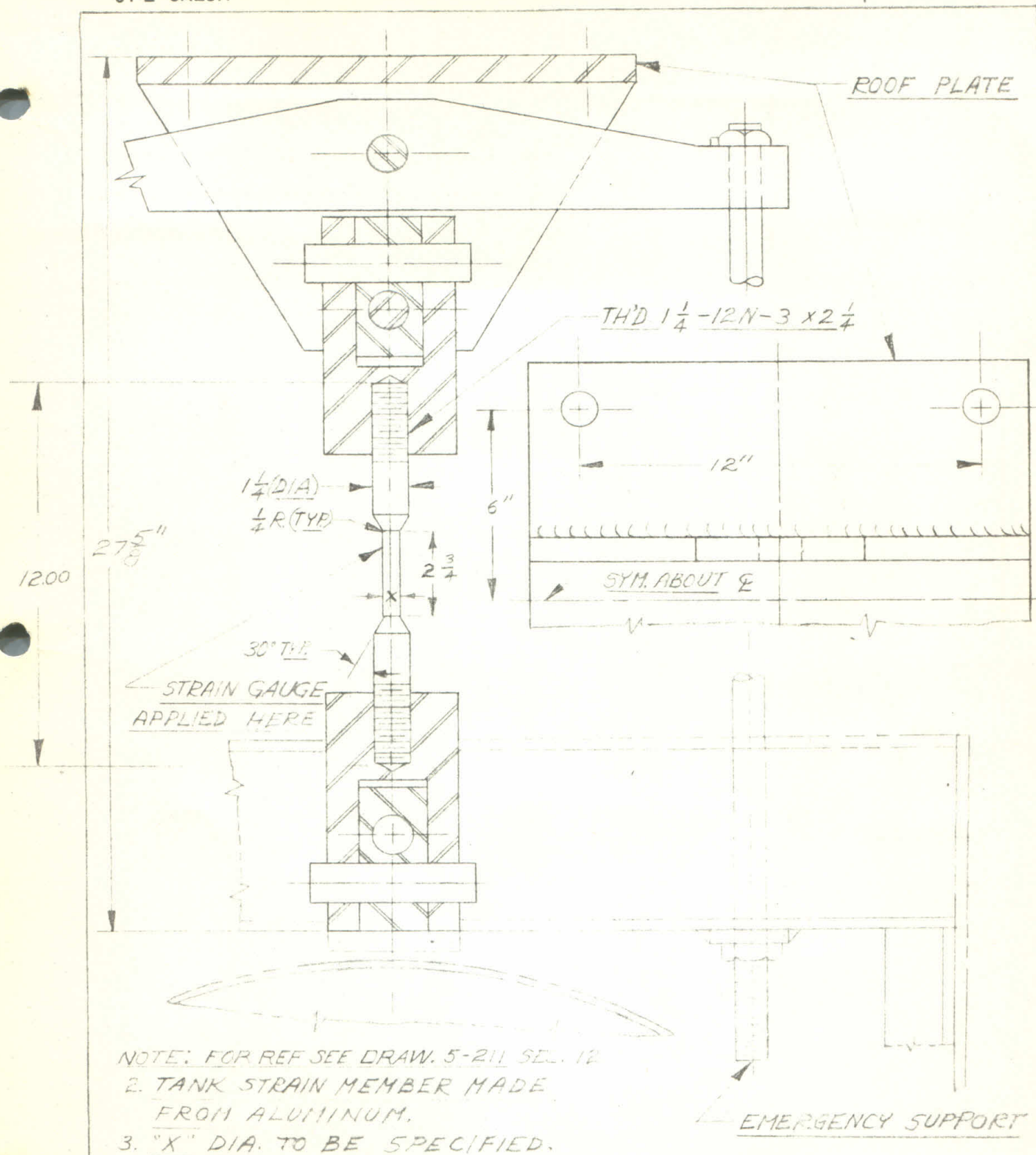
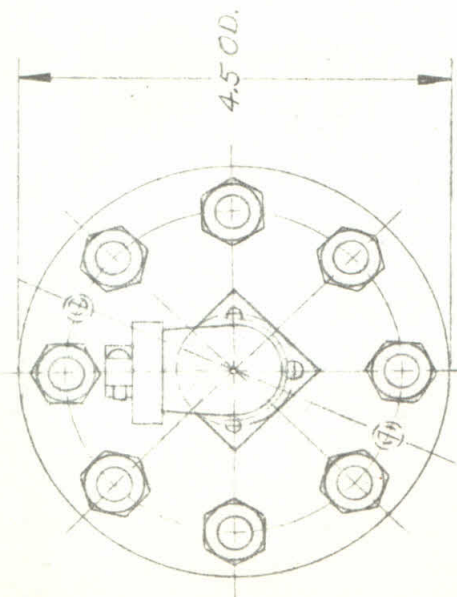
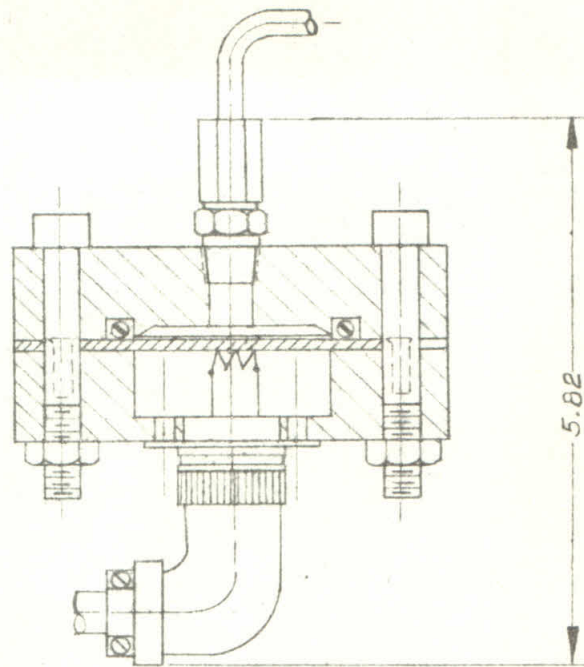


FIG. 43  
TANK STRAIN MEMBER





NOTE: FOR REF. SEE DRAW. 2-108-A

Fig 44. STRAIN GAUGE PRESSURE TRANSMITTER

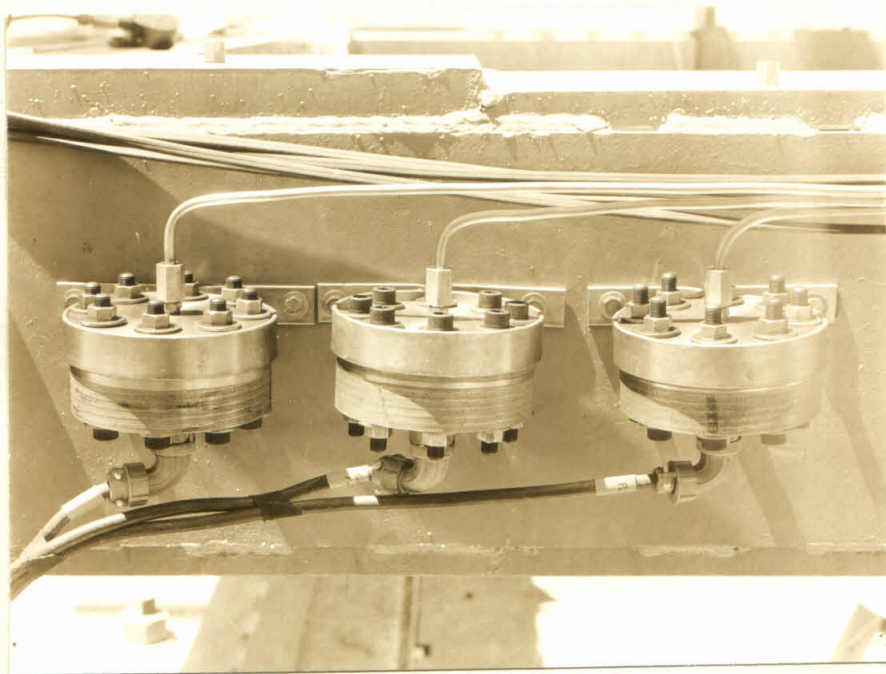


Fig 45. Pressure Transmitters Installed at the Test Stand.

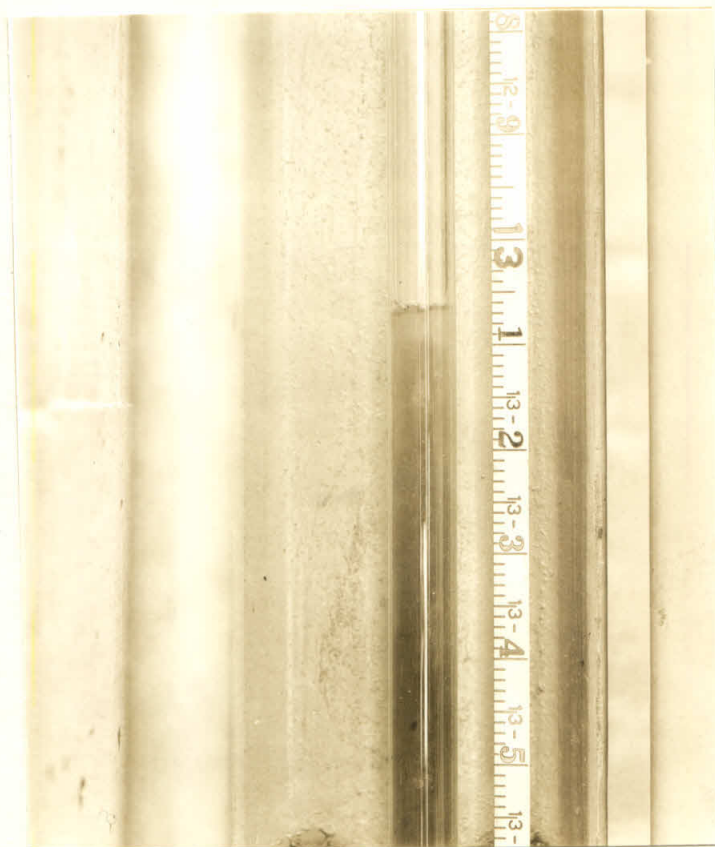


Fig 46. Propellant Tank Sight Glass Showing Fluid Level and Steel Tape.



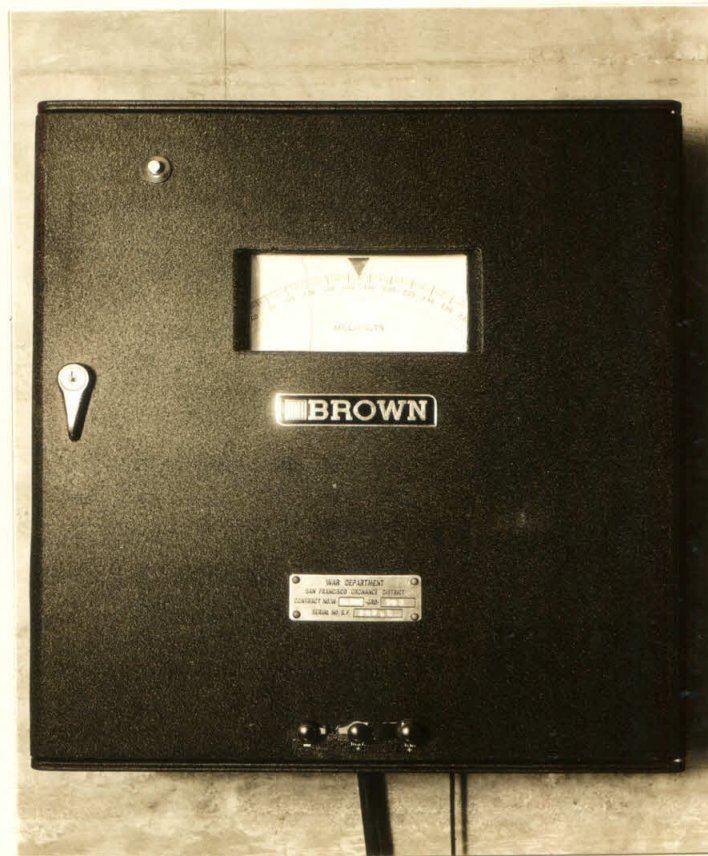


Fig 47. Brown Indicating Potentiometer.

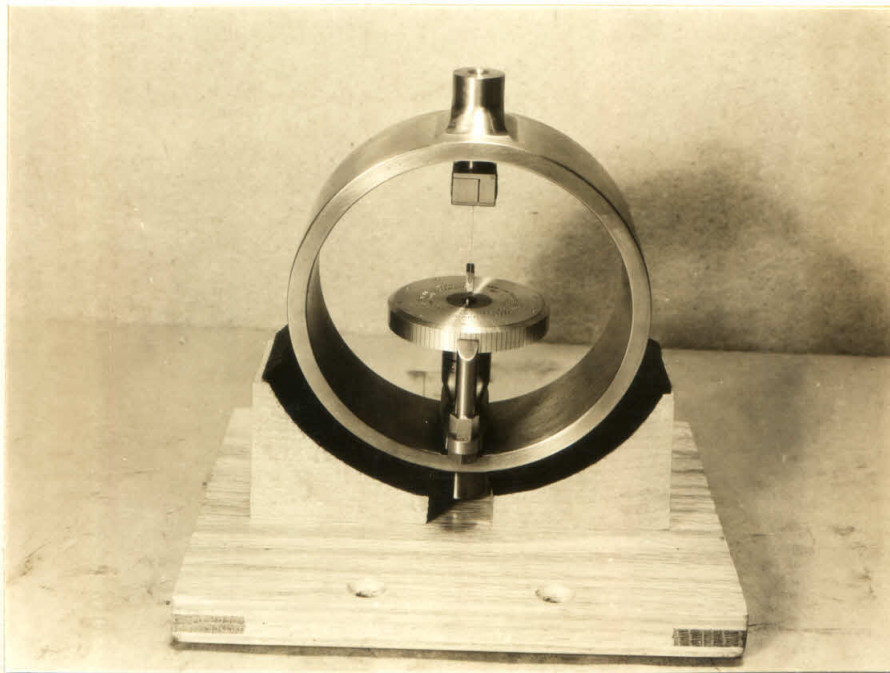


Fig 48. 500-Lb Proof Ring.

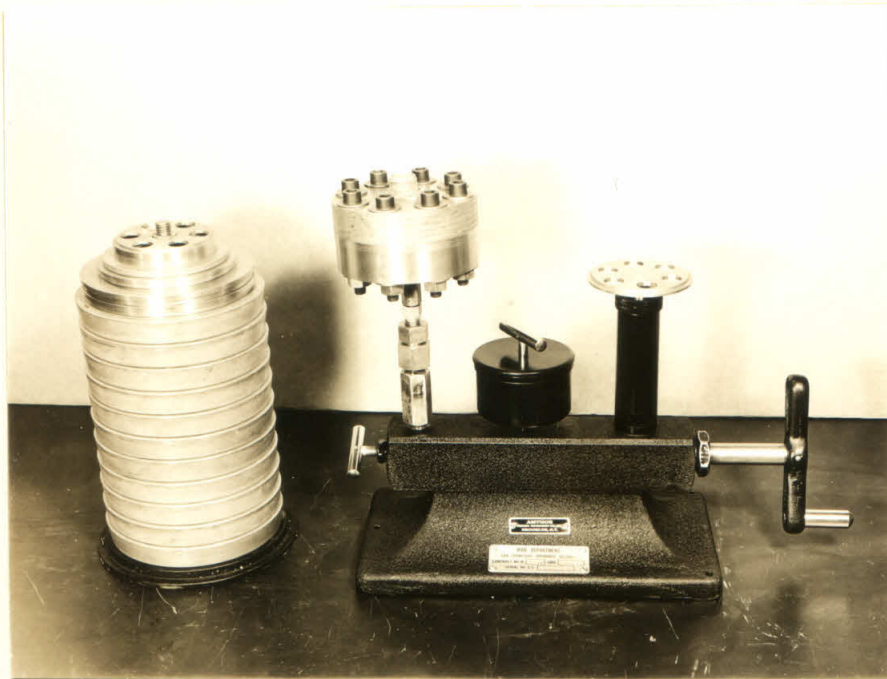


Fig 49. Anthor Dead Weight Tester.





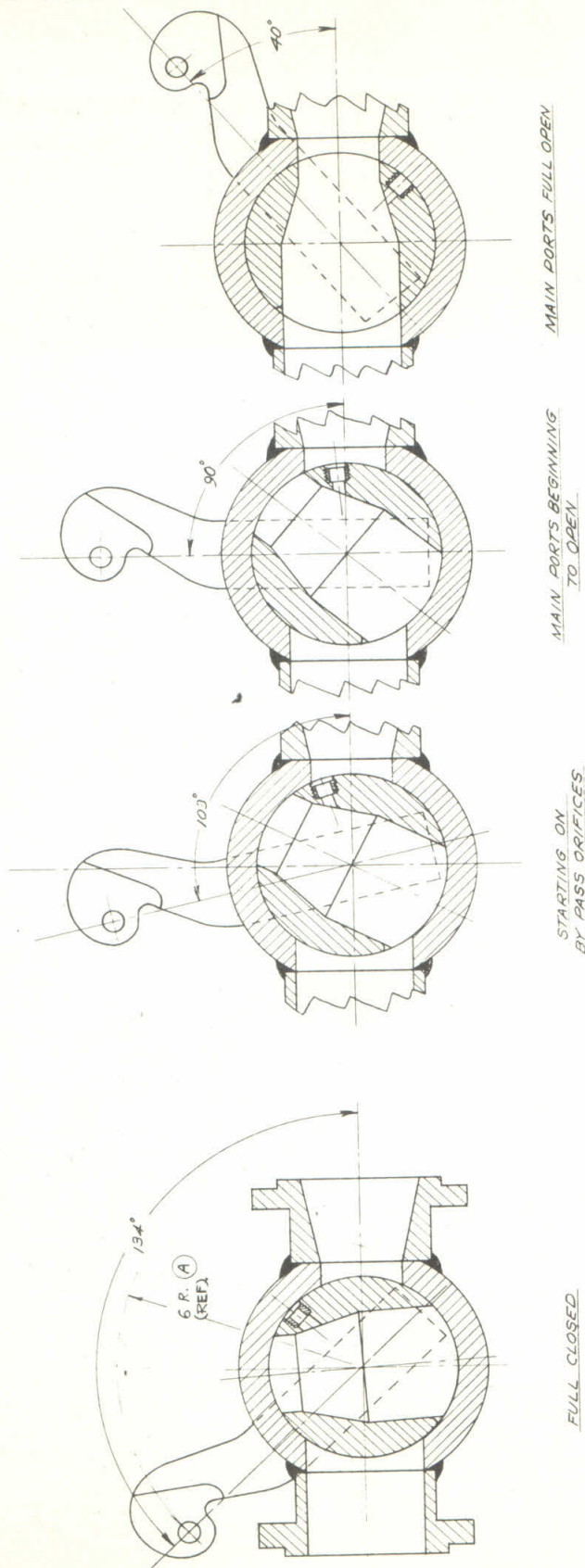
Fig 50. 300-Lb Capacity Platform Balance.

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PROJECT DESIGNATION <u>5000</u>		SECTION <u>8</u> PROJECT CLASSIFICATION <u>CONFIDENTIAL</u>	
1. TITLE <u>VALVE ASSEMBLY, ROTARY</u> 2. SUBTITLE <u>PLUG THROTTLE</u> 3. NUMBER <u>144</u>		4. DATE <u>10-15-54</u> <u>REVISED</u> 5. BY <u>W. H. H. H.</u> 6. CHECKED <u>W. H. H. H.</u> 7. APPROVED <u>W. H. H. H.</u> 8. <u>144</u>	
9. <u>144</u> 10. <u>144</u> 11. <u>144</u> 12. <u>144</u> 13. <u>144</u> 14. <u>144</u> 15. <u>144</u> 16. <u>144</u> 17. <u>144</u> 18. <u>144</u> 19. <u>144</u> 20. <u>144</u> 21. <u>144</u> 22. <u>144</u> 23. <u>144</u> 24. <u>144</u> 25. <u>144</u> 26. <u>144</u> 27. <u>144</u> 28. <u>144</u> 29. <u>144</u> 30. <u>144</u> 31. <u>144</u> 32. <u>144</u> 33. <u>144</u> 34. <u>144</u> 35. <u>144</u> 36. <u>144</u> 37. <u>144</u> 38. <u>144</u> 39. <u>144</u> 40. <u>144</u> 41. <u>144</u> 42. <u>144</u> 43. <u>144</u> 44. <u>144</u> 45. <u>144</u> 46. <u>144</u> 47. <u>144</u> 48. <u>144</u> 49. <u>144</u> 50. <u>144</u> 51. <u>144</u> 52. <u>144</u> 53. <u>144</u> 54. <u>144</u> 55. <u>144</u> 56. <u>144</u> 57. <u>144</u> 58. <u>144</u> 59. <u>144</u> 60. <u>144</u> 61. <u>144</u> 62. <u>144</u> 63. <u>144</u> 64. <u>144</u> 65. <u>144</u> 66. <u>144</u> 67. <u>144</u> 68. <u>144</u> 69. <u>144</u> 70. <u>144</u> 71. <u>144</u> 72. <u>144</u> 73. <u>144</u> 74. <u>144</u> 75. <u>144</u> 76. <u>144</u> 77. <u>144</u> 78. <u>144</u> 79. <u>144</u> 80. <u>144</u> 81. <u>144</u> 82. <u>144</u> 83. <u>144</u> 84. <u>144</u> 85. <u>144</u> 86. <u>144</u> 87. <u>144</u> 88. <u>144</u> 89. <u>144</u> 90. <u>144</u> 91. <u>144</u> 92. <u>144</u> 93. <u>144</u> 94. <u>144</u> 95. <u>144</u> 96. <u>144</u> 97. <u>144</u> 98. <u>144</u> 99. <u>144</u> 100. <u>144</u>		1. <u>144</u> 2. <u>144</u> 3. <u>144</u> 4. <u>144</u> 5. <u>144</u> 6. <u>144</u> 7. <u>144</u> 8. <u>144</u> 9. <u>144</u> 10. <u>144</u> 11. <u>144</u> 12. <u>144</u> 13. <u>144</u> 14. <u>144</u> 15. <u>144</u> 16. <u>144</u> 17. <u>144</u> 18. <u>144</u> 19. <u>144</u> 20. <u>144</u> 21. <u>144</u> 22. <u>144</u> 23. <u>144</u> 24. <u>144</u> 25. <u>144</u> 26. <u>144</u> 27. <u>144</u> 28. <u>144</u> 29. <u>144</u> 30. <u>144</u> 31. <u>144</u> 32. <u>144</u> 33. <u>144</u> 34. <u>144</u> 35. <u>144</u> 36. <u>144</u> 37. <u>144</u> 38. <u>144</u> 39. <u>144</u> 40. <u>144</u> 41. <u>144</u> 42. <u>144</u> 43. <u>144</u> 44. <u>144</u> 45. <u>144</u> 46. <u>144</u> 47. <u>144</u> 48. <u>144</u> 49. <u>144</u> 50. <u>144</u> 51. <u>144</u> 52. <u>144</u> 53. <u>144</u> 54. <u>144</u> 55. <u>144</u> 56. <u>144</u> 57. <u>144</u> 58. <u>144</u> 59. <u>144</u> 60. <u>144</u> 61. <u>144</u> 62. <u>144</u> 63. <u>144</u> 64. <u>144</u> 65. <u>144</u> 66. <u>144</u> 67. <u>144</u> 68. <u>144</u> 69. <u>144</u> 70. <u>144</u> 71. <u>144</u> 72. <u>144</u> 73. <u>144</u> 74. <u>144</u> 75. <u>144</u> 76. <u>144</u> 77. <u>144</u> 78. <u>144</u> 79. <u>144</u> 80. <u>144</u> 81. <u>144</u> 82. <u>144</u> 83. <u>144</u> 84. <u>144</u> 85. <u>144</u> 86. <u>144</u> 87. <u>144</u> 88. <u>144</u> 89. <u>144</u> 90. <u>144</u> 91. <u>144</u> 92. <u>144</u> 93. <u>144</u> 94. <u>144</u> 95. <u>144</u> 96. <u>144</u> 97. <u>144</u> 98. <u>144</u> 99. <u>144</u> 100. <u>144</u>	

PROJECT CLASSIFICATION CONFIDENTIAL

PAGE  
FIGURE

JPL-GALCIT



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PROJECT DESIGNATION		SECTION 8 PROJECT CLASSIFICATION <u>CONFIDENTIAL</u>	
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CHK.	W. B. B. 11-45	SCALE HALF	
APP.	A. B. 11-45	PART	
TOLERANCE		DRAWING NO.	
±.01 unless otherwise noted		4-915-A	
BY JAD		PART	
DATE		PART	
CHANGE		PART	



PROJECT CLASSIFICATION

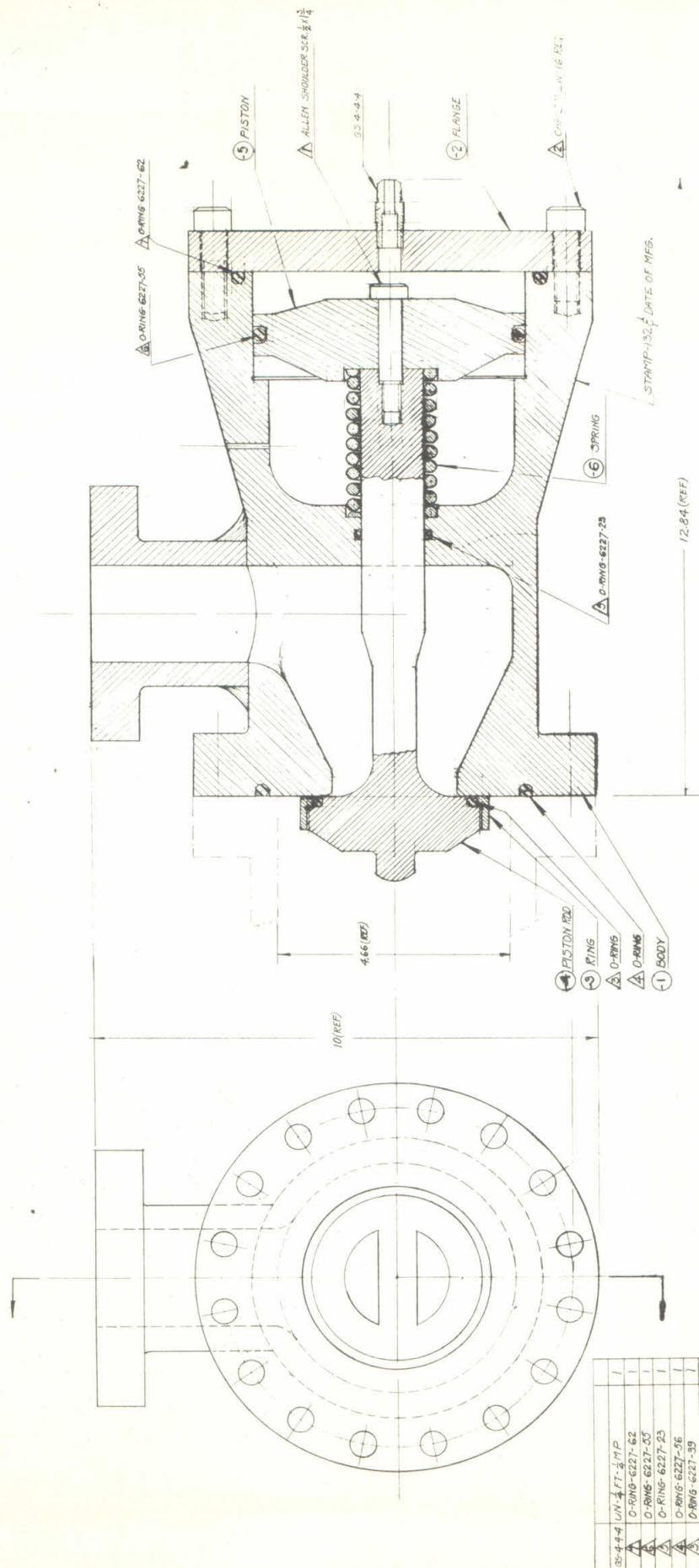


Fig 53. ASSEMBLY, 2-INCH SHUT-OFF VALVE

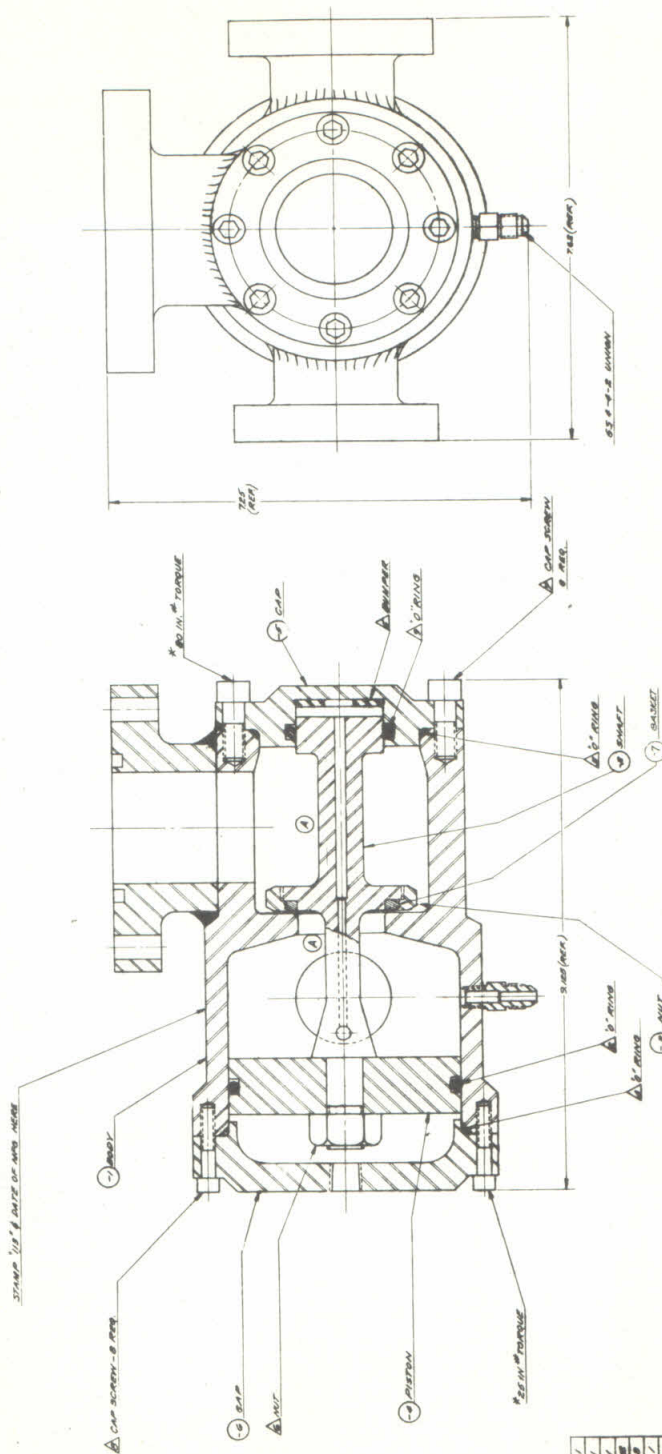
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1	O-RING-6227-35	1
1	O-RING-6227-25	1
1	O-RING-6227-36	1
1	O-RING-6227-39	1
1	ALLEN SCREW NO. 2-20 MP 3 x 1/2	16
1	SPRING	1
1	PISTON	1
1	PISTON ROD	1
1	RING	1
1	FLANGE	1
1	BODY	1
1	ASSEMBLY	1

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PROJECT DESIGNATION: MX121-1  
SECTION: 5  
PROJECT CLASSIFICATION: RESTRICTED  
DATE: 12-1-53  
BY: JPL-100  
CHECKED: JPL-100  
APPROVED: JPL-100  
STAMP-132, DATE OF MFG.

PROJECT CLASSIFICATION CONFIDENTIAL



ITEM	DESCRIPTION	QTY	UNIT	REMARKS
1	SAFETY	1		
2	1/8" PLUG - ANGLE-12	1		
3	1/8" PLUG - ANGLE-12	1		
4	1/8" PLUG - ANGLE-12	1		
5	1/8" PLUG - ANGLE-12	1		
6	1/8" PLUG - ANGLE-12	1		
7	1/8" PLUG - ANGLE-12	1		
8	1/8" PLUG - ANGLE-12	1		
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53	1/8" PLUG - ANGLE-12	1		
54	1/8" PLUG - ANGLE-12	1		
55	1/8" PLUG - ANGLE-12	1		
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57	1/8" PLUG - ANGLE-12	1		
58	1/8" PLUG - ANGLE-12	1		
59	1/8" PLUG - ANGLE-12	1		
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98	1/8" PLUG - ANGLE-12	1		
99	1/8" PLUG - ANGLE-12	1		
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JET PROPULSION LABORATORY, MSMT

PROJECT CLASSIFICATION: CONFIDENTIAL

REPORT NO. 4-25

DATE: 5-18-65

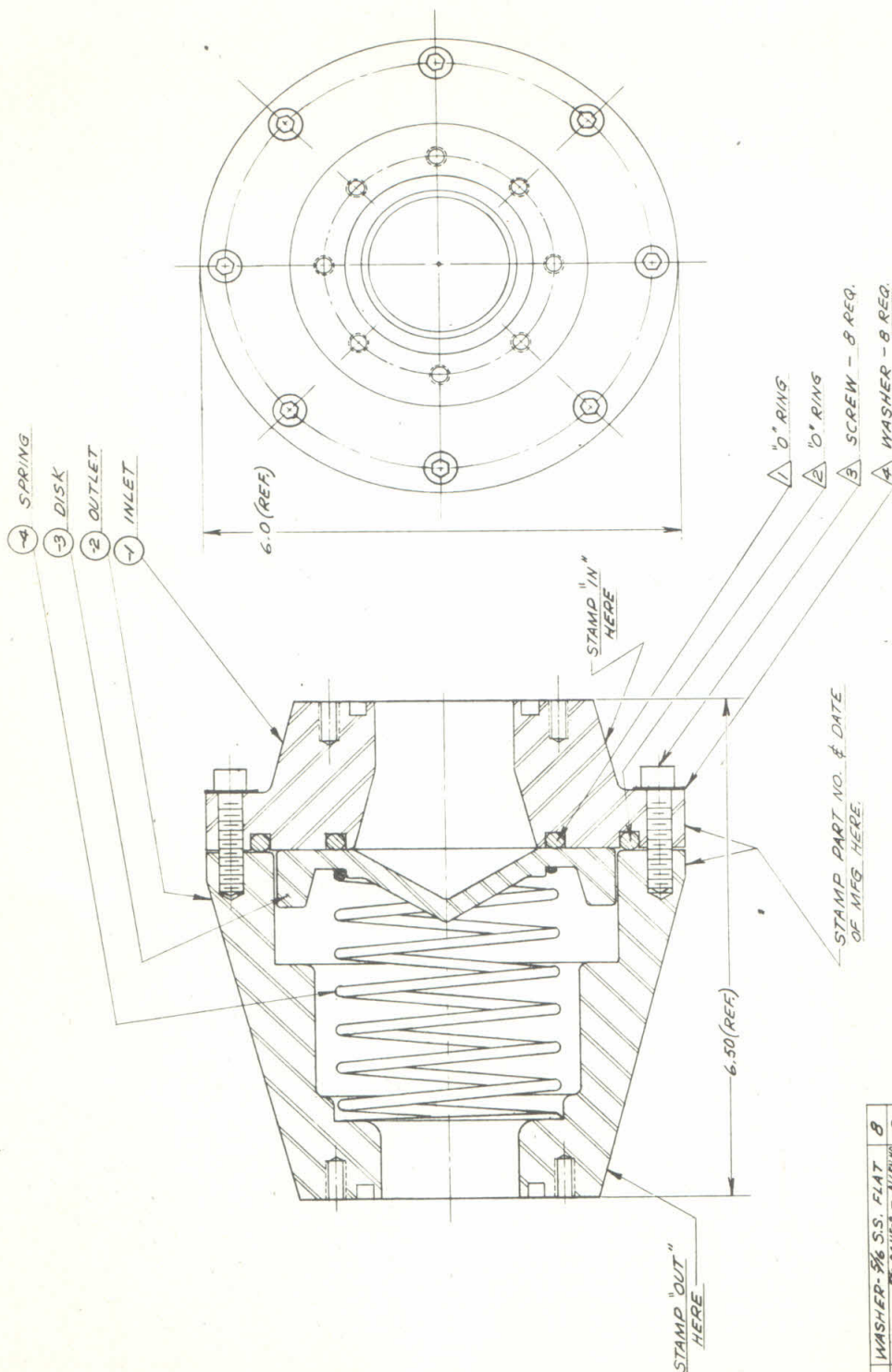
BY: J. L. GALT

FOR: JPL-GALCIT

FIG. 54

PLEASE PRINTING INSTRUCTIONS FOR PRINTING CAP-SCREENS

PROJECT CLASSIFICATION CONFIDENTIAL





PART	DESCRIPTION	QTY
1	WASHER - 3/16" S.S. FLAT	8
2	SCREW - 1/4" S.S. - ALLIANCE	8
3	DISK - 1/4" S.S. - ALLIANCE	1
4	OUTLET - 1/4" S.S. - ALLIANCE	1
5	INLET - 1/4" S.S. - ALLIANCE	1
6	SPRING - 1/4" S.S. - ALLIANCE	1
7	DISK - 1/4" S.S. - ALLIANCE	1
8	OUTLET - 1/4" S.S. - ALLIANCE	1
9	INLET - 1/4" S.S. - ALLIANCE	1
10	ASSEMBLY	1

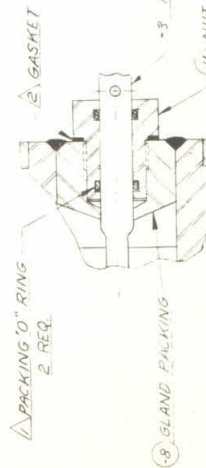
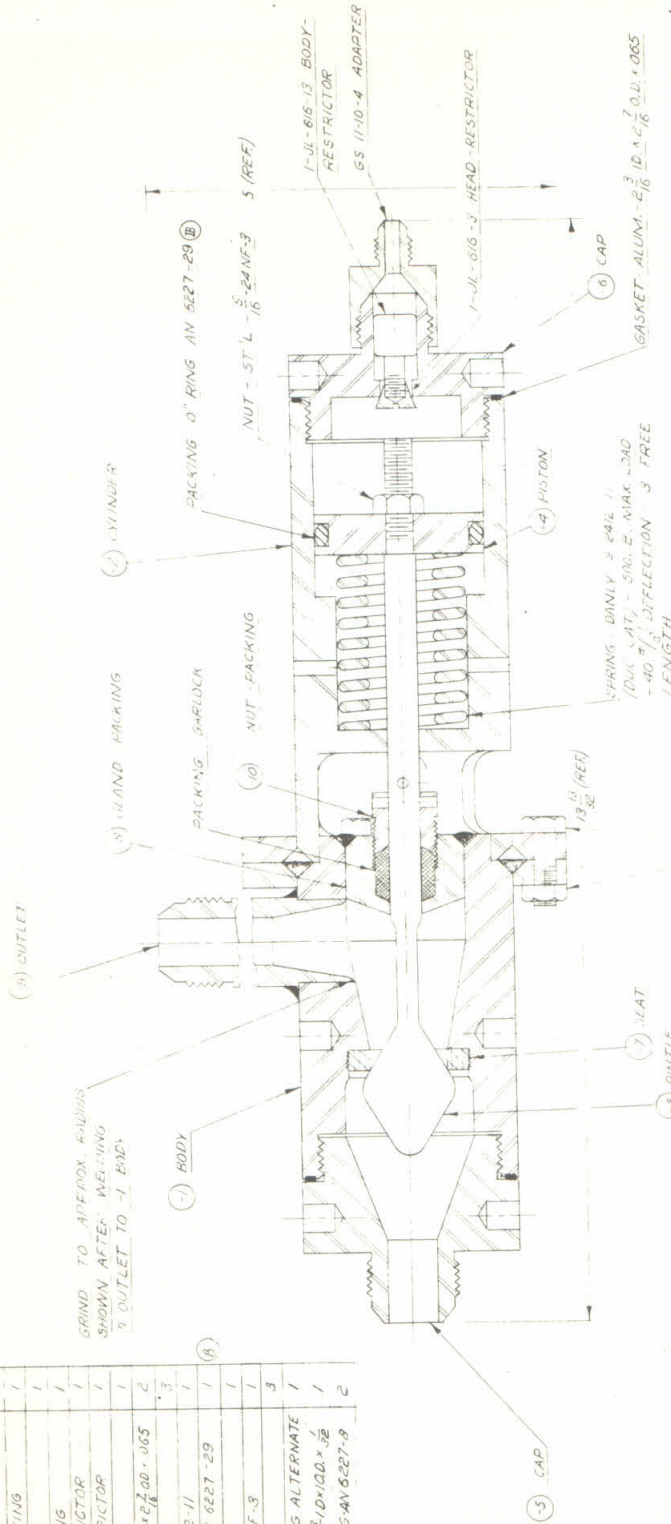
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JET PROPULSION LABORATORY, GALCIT		CALIFORNIA INSTITUTE OF TECHNOLOGY	
PROJECT DESIGNATION	MODEL	SECTION	PROJECT CLASSIFICATION
This document contains information affecting the National Defense of the United States within the meaning of Espionage Act, U.S.C. 561 and 562, the transmission or the revelation of its contents in any manner to an unauthorized person is prohibited by law.			
DATE	1/23/45	MATERIAL	NOTED
BY	1/23/45	SCALE	1/2" = 1"
APP'D	1/23/45	DESIGN	1/2" = 1"
ENG	1/23/45	TEST	1/2" = 1"
VALVE ASSEMBLY - 1/2"		TUBE CHECK	
4-129		DRAWING NO.	



CONFIDENTIAL

PART	DESCRIPTION	QTY
4-UL-650	ASS'Y BELLY	1
-1	BODY	1
-2	CYLINDER	1
-3	PIN TLE	1
-4	PISTON	1
-5	CAP	1
-6	CAP	1
-7	SEAT	1
-8	GLAND - PACKING	1
-9	OUTLET	1
-10	NUT - PACKING	1
1-UL-616-3	HEAD - RESTRICTOR	1
1-UL-616-13	BODY - RESTRICTOR	1
GS 11-10-4	ADAPTER	2
GASKET	ALUM. - $\frac{5}{16}$ " ID $\times$ 2.00 - .065	2
ROLT	AN 4 TH	3
SPRING	DANLY 8-2412-11	1
PACKING	O-RING - AN 6227 -29	1
PACKING	GARLOCK	1
NUT	ST L - $\frac{5}{16}$ " 24NF-3	1
NUT	AN 315-4R	3
-11	NUT PACKING ALTERNATE	1
	GASKET-ALUM. $\frac{3}{16}$ " ID $\times$ 1.00 $\times$ .56	1
	PACKING O-RING-AN 6227-8	2



ALTERNATE PA A VS

ROUT - AN 4-7A - 3 REQ

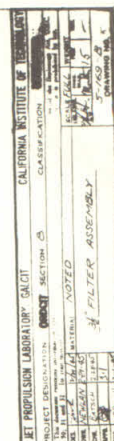
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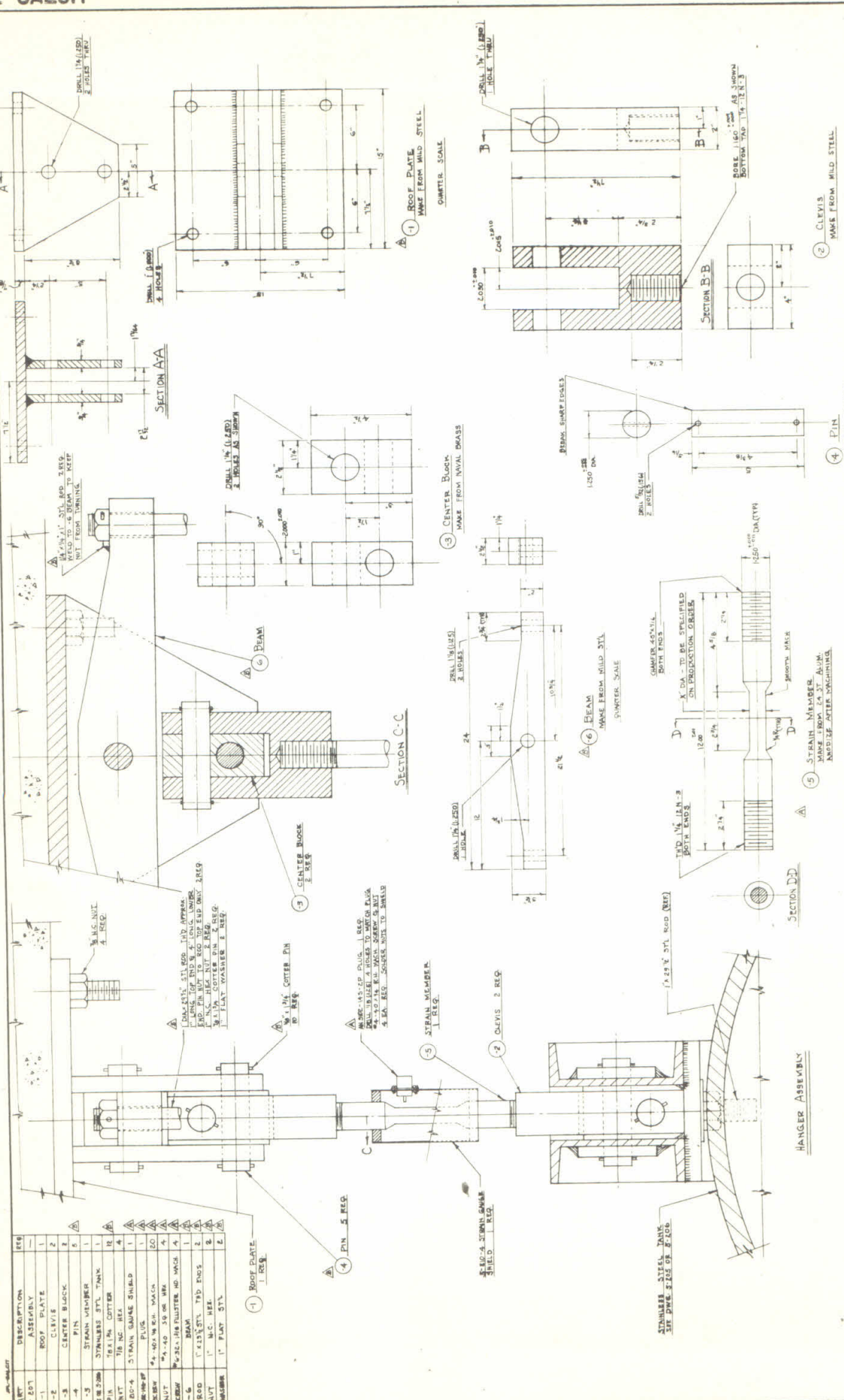
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NOTE:



DATE	TYPE OF ACTION	REMARKS	BY	DATE
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PROJECT CLASSIFICATION



**PROJECT CLASSIFICATION**

**SECTION 12**

**PROJECT CLASSIFICATION**

**ASSEMBLY AND DETAILS - TEST**

**JIND PROPELLANT TANK HANGER**

**5-11**

**NOTE:**

1. ALL DIMENSIONS IN INCHES

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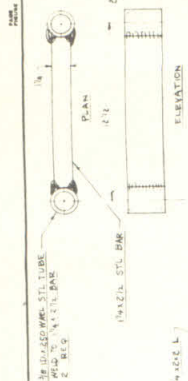
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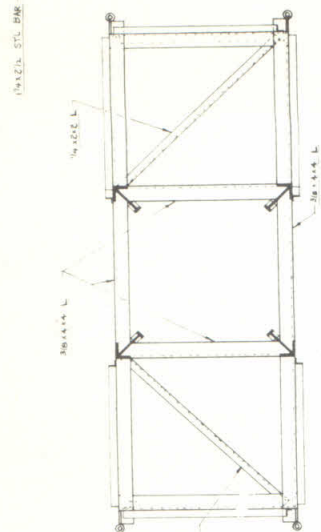




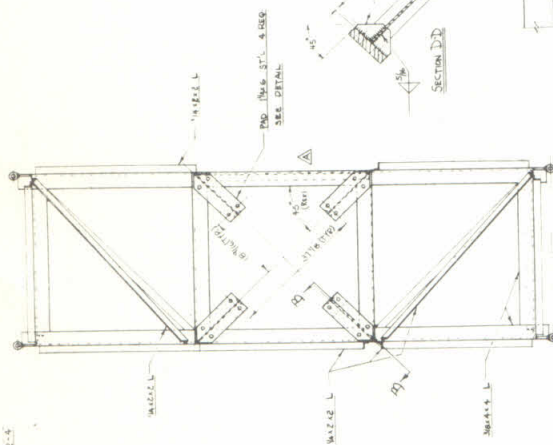
PROJECT CLASSIFICATION



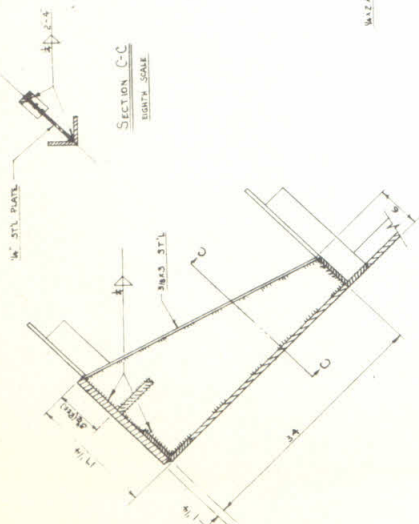
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QUARTER SCALE



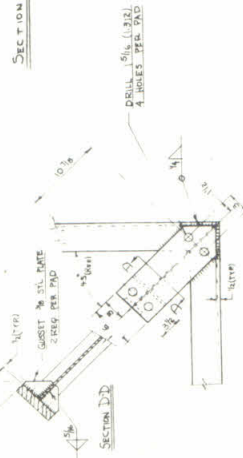
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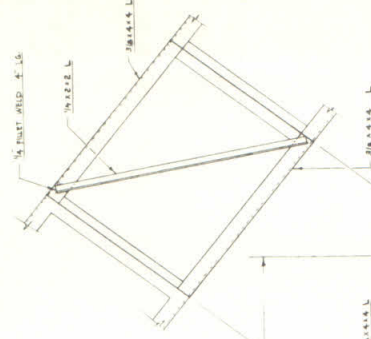
SECTION BB  
FULL SCALE



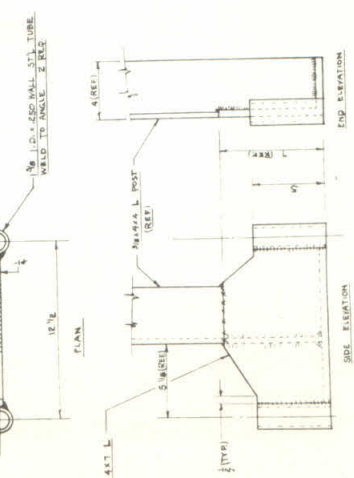
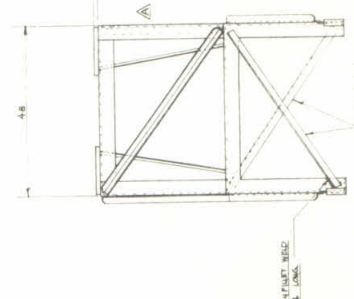
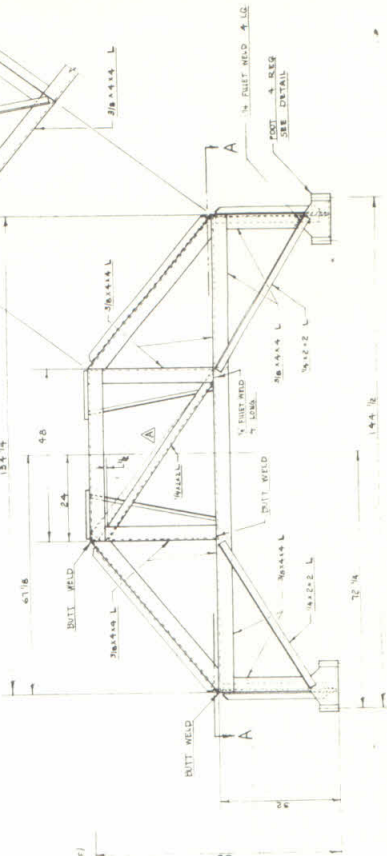
SECTION CC  
QUARTER SCALE



TYPICAL PAD DETAIL  
FULL SCALE



SECTION DD



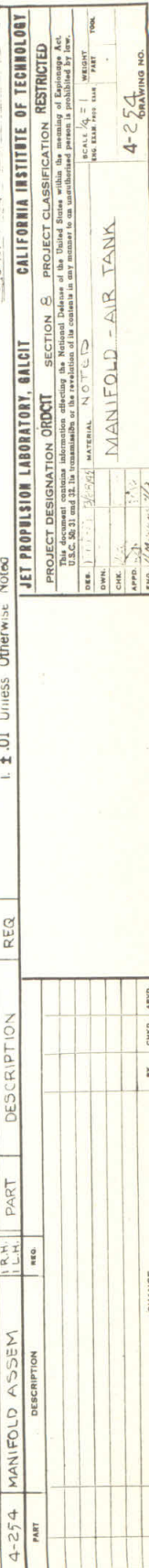
SECTION GG  
QUARTER SCALE

JET PROPULSION LABORATORY, CALIF.	
SECTION 12 PROJECT CLASSIFICATION	
PROJECT DESIGNATION	
PROJECT DESCRIPTION	
DATE: 10/11/50	
DRAWN BY: J. J. J.	
CHECKED BY: J. J. J.	
APPROVED BY: J. J. J.	
MOTOR MOUNT - TEST STAND	
BALANCE FRAMEWORK	
5-212	

- NOTE: -
1. ALL DIMENSIONS IN INCHES
  2. TRIM SPOKE CORNERS ON DIAGONAL BRACING
  3. DIMENSIONS TO CENTER OF GRAVITY UNLESS OTHERWISE SPECIFIED
  4. FINISH TO PLATE OF BOTTOM FLANGE, IF FEEL

PART	DESCRIPTION	QTY	DATE	BY	CHKD	APPD
1	CLAMP	1				
2	CLAMP	1				
3	CLAMP	1				
4	CLAMP	1				
5	CLAMP	1				
6	CLAMP	1				
7	CLAMP	1				
8	CLAMP	1				
9	CLAMP	1				
10	CLAMP	1				

PAGE  
FIGURE

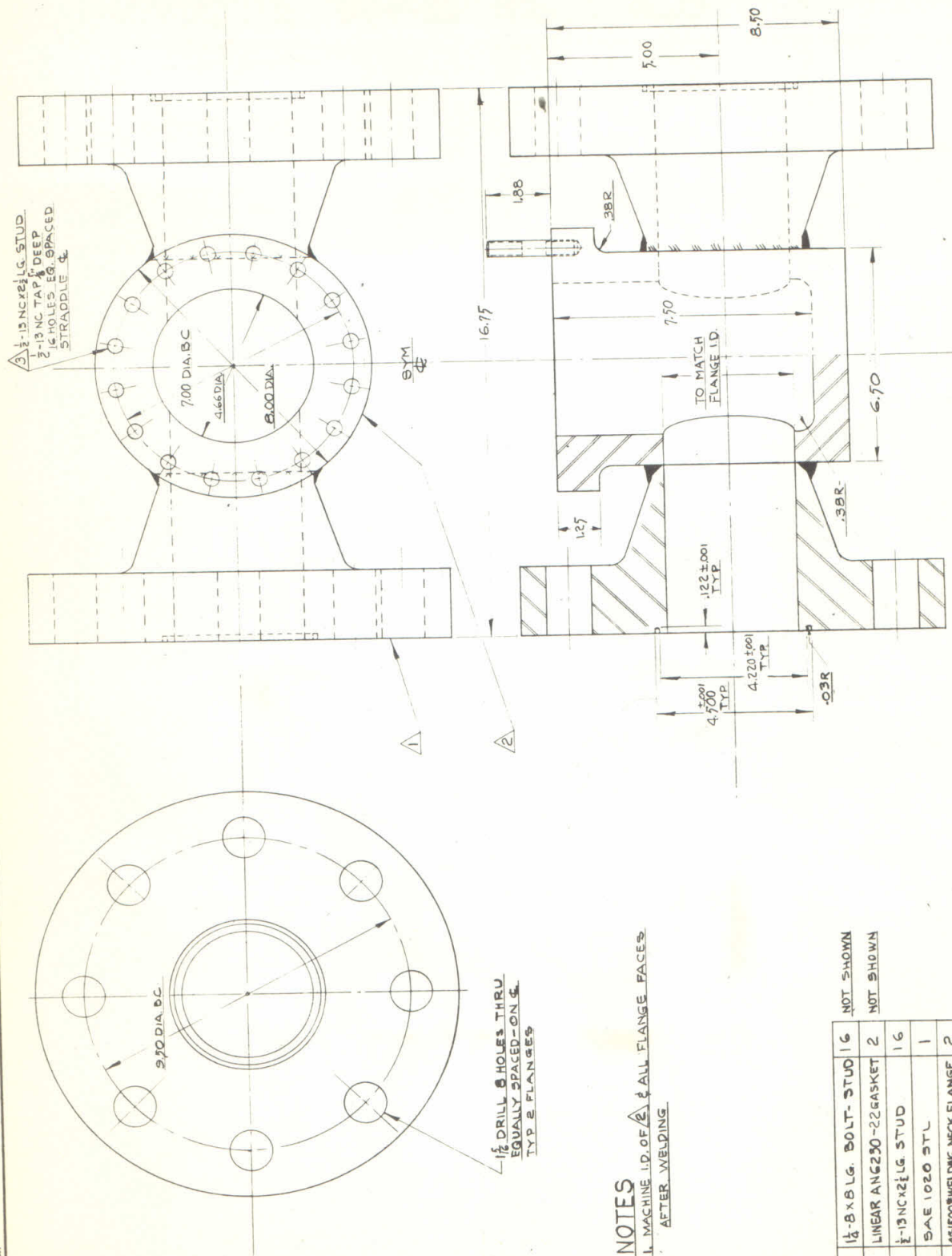




PAGE 100

PROJECT CLASSIFICATION

JPL-04LCIT



## NOTES

- NOTES
1. MACHINE I.D. OF  $\Delta$  & ALL FLANGE FACES AFTER WELDING

**TOLERANCE**  
+ .01 Unless Otherwise Noted

	NOT SHOWN	NOT SHOWN
1/8" X 8 LG. BOLT- STUD	16	
LINEAR AN230-22 GASKET	2	
1/2" X 3/4" X 2 LG STUD	16	
SAE 1020 STL	1	
4" X 1/2" WELDING NECK FLANGE	2	

[illegible]

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MATERIAL NOTED		RECEIVED	
COPIES	12645	NO. EXAM. FILE	PART
POWER		WEIGHT	
DATE	27 Feb 45		
TEE-AIR TANK MANIFOLD		4-249	
		EXPIRATION NO.	

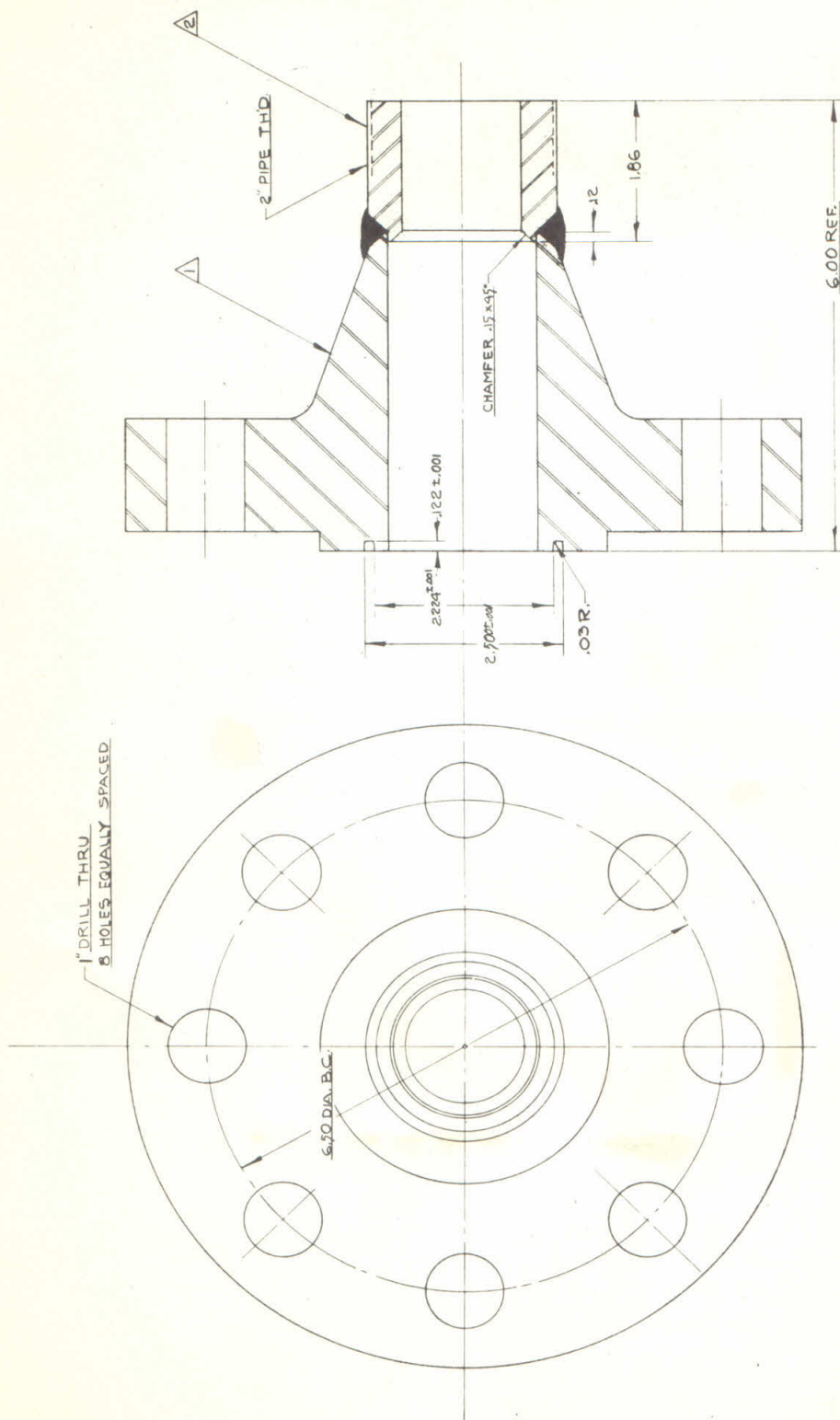
TEE-AIR TANK MANIFOLD

4-249

4-249 Drawing no.

DECEMBER 1977

2000  
2001  
2002



4-250	FLANGE ASSEMBLY	1
△	2" DOUBLE EXTRA STRONG PIPE	1
△	8" MC X 14 LB. BOLT - STUDS	6
△	LINEAR ANCHORING GASKET	1
	NOT SHOWN	
	NOT SHOWN	

**TOLERANCE**  
 ±.01 Unless Otherwise Noted

[illegible]

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DATE	EXPIRATION	INTERNAL	EXTERNAL
10/1/54	10/1/54		
WORKING	CHG	REVISIONS	SCALE
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